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An empirical study of high school principals' data -driven decision-making practices and their relationships to contextual variables

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AN EMPIRICAL STUDY OF HIGH SCHOOL PRINCIPALS' DATA-DRIVEN DECISION-MAKING PRACTICES AND THEIR RELATIONSHIPS TO CONTEXTUAL VARIABLES

by

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Mingchu Luo, Ed.D.

University of Nebraska, 2005

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The purpose of this study was to examine the extent to which Nebraska high school principals practiced data-driven decision-making and to determine the relationships between principals' data-driven decision-making and the contextual factors. The following leadership dimensions were surveyed: school vision, school instruction, school organization, collaborative partnerships, moral perspective, and larger-context politics. Three categories of contextual variables were included for study: principal characteristics as people factors, leadership dimensions as problem factors, and school setting as organization factors.

The study results indicate that data-driven decision-making was practiced frequently by the principals in the leadership dimensions of instruction, organizational operation, and school vision. Principals used data in instructional and organization operational leadership more frequently than in the leadership dimensions of school vision, collaborative partnerships, and larger-context politics. There were no significant demographic effects on data-driven decision-making. Data analysis skills, attitudes towards data, the access to data, and the data use requirement of school district were the dimensions that significantly influenced data-driven decision-making.

An integrated analysis approach reveals differences in contextual factors that impacted data use on different leadership dimensions. Person-related or internal factors such as principals' perceptions of data quality and data analysis skills tended to contribute to data use in leadership areas, where data-driven decision-making was extensively practiced, well-accepted, reinforced, and used for ill-structured problems. Organization-related or external factors such as school district requirement and data accessibility tended to influence data use in leadership areas, where data-driven decision-making was at the initial stage, less frequently practiced, vaguely controversial, and used for well-structured problems. The recognition level of data-driven decision-making and information processing level seemed to match the frequency level of data-driven decision-making.

This study supports Taylor's (1991) Information Use Environment model and the Choo's (1998) information behavior propositions that information use for decision-making is situational and dynamic. In light of this finding, an integrated model of practical strategies was recommended to create a supportive information use environment for better data-driven decision-making by balancing data-driven decision-making practices in leadership dimensions, strengthening principals' data analysis skills, using district policy requirement appropriately, creating supportive and effective teamwork, adopting different strategies for different administrative dimensions, and nurturing a data-driven culture.

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Introduction

The passage and implementation of the No Child Left Behind (NCLB) Act (2002) opened a new era of educational accountability and school improvement. This historic reform gives states and school districts increased flexibility in how they spend their money in return for setting student achievement standards and holding students and educators accountable for results. NCLB significantly increases the pressure on states, districts, and schools to collect, analyze, and report data. "In God we trust; all others bring data" captures the essence of NCLB. Phrases like "evidence-based decisions" and "scientifically based research" occur 111 times in NCLB (Mann & Shakeshaft, 2003; Slavin, 2003). Accountability demands are now forcing school leaders to explore much more the granular data and to do more sophisticated analyses. Data-driven decision-making is an emerging field of practice for school leadership (Streifer, 2002). Nationwide standards-based control and outcome-based funding have brought data-driven decision-making to the top of every principal's agenda (Leithwood, Aitken, & Jantzi, 2001; Thornton & Perreault, 2002).

States such as California, Colorado, Illinois, Iowa, Maryland, Virginia, Wisconsin, and Wyoming require data-driven decision-making at the policy level. Many educational professional associations and agencies such as the American Association of School Administrators (AASA), the Education Commission of the States (ECS), the National School Board Association (NSBA), the National Staff Development Council (NSDC), and the North Central Regional Educational Laboratory (NCREL) have made data-driven decision-making an important topic on

their official websites. Such organizations also offer training programs and workshops across the country. Books and journal articles on how to use data for decision-making in schools are becoming common-place.

In January 2002, the National Policy Board for Educational Administration published the revised Standards for Advanced Programs in Educational Leadership, which were developed and revised by the Educational Leadership Constituent Council (ELCC) (2002) and adopted by the National Council for the Accreditation of Teacher Education (NCATE) (2002). As compared to the old standards, the new standards have more emphasis placed on school administrators' ability and knowledge in using data. Data-driven decision-making is integral to the key school administrators' skills in the six area standards of school vision, school instruction, school organization, collaborative partnerships, moral perspective, and larger-context politics.

It is appropriate to ask what the current realities of data-driven decision-making practices are in schools, and what factors affect those practices. These are critical issues in both practice and research, yet surprisingly little empirical research has actually been conducted on these issues, especially from the principal's perspective.

The ELCC/NCATE (2002) standards serve as school leadership preparation program standards and can be used as a cornerstone for the professional development of existing school administrators (Murphy & Shipman, 1998; Murphy, Yff, & Shipman, 2000). The standards also provide evidence for the licensure of principals and a common set of guidelines for ELCC/NCATE accreditation of advanced

programs in Educational Leadership in America. The ELCC standards were used as the framework for this study, through which high school principals' data-driven decision-making practices were examined in each of the six leadership dimensions: school vision, school instruction, school organization, collaborative partnerships, moral perspective, and larger-context politics.

Purpose of the Study

The purposes of this survey study were to

1. Examine the extent to which high school principals apply data-driven decision-making in addressing the ELCC/NCATE standards;
2. Determine if the demographics of high school principals and their schools significantly affect their data-driven decision-making practices;
3. Identify factors in the principals' work environments that may affect their data-driven decision-making practices.

Research Questions

This study addressed the following research questions:

1. To what extent do high school principals practice data-driven decision-making in addressing the administrative problems of the leadership dimensions developed by the ELCC/NCATE: school vision, school instruction, school organization, moral perspective, collaborative partnerships, and larger-context politics? Are there any differences in the extent of principals' data-driven decision-making practices among these leadership dimensions?

2. Are high school principals' data-driven decision-making practices significantly affected by the following demographic variables: (a) principal's age, (b) gender, (c) ethnicity, (d) educational attainment, (e) length of total school administrative experience (f) length of holding the principal position at current school, (g) school size, and (h) school socio-economic status (SES)?
3. Is there a significant relationship between principals' data-driven decision-making practices and their level of data analysis skills?
4. Is there a significant relationship between principals' data-driven decision-making practices and the following school or district operational features: (a) school districts that have a requirement for data-driven decision-making versus those that do not have a requirement for data-driven decision-making, (b) high schools that have a data analysis team in the school versus those that do not have a data analysis team, and (c) level of principals' accessibility of data for decision-making?
5. Is there a significant relationship between principals' data-driven decision-making practices and their perceptions of data quality?
6. Can the following factors significantly predict principals' data-driven decision-making practices: (a) principals' data analysis skills, (b) school districts that have a requirement for data-driven decision-making versus those that do not have a requirement for data-driven decision-making; (c) high schools that have a data analysis team in the school versus those that do not have a data analysis team, (d) level of principals' accessibility of

data for decision-making, and (e) principals' perceptions of data quality? If so, which factors are most influential? Are there any variables that do not contribute significantly to the prediction model?

Significance of the Study

Contribution to Research

Very limited quantitative research literature is available on principal data-driven decision-making. No quantitative study has been conducted on this topic from the high school principals' perspective. There is no comprehensive research on the relationship between the school contextual factors and high school principals' practices of data-driven decision-making. This study helps to fill that void.

Contribution to Practice

The results of this study are valuable to practice in four ways. First, results of this survey study present a rather complete picture of high school principals' data-driven decision-making practices in Nebraska. School district authorities can better understand the extent of principals' data-driven decision-making and the factors affecting these practices. Results of the study may help district-level administrators understand, assist and support their principals in light of the factors that impact their practices. Second, policies related to principals' data-driven decision-making are increasingly important for both the state department of education and the school districts with the implementation of NCLB (2002). Policy makers need current, comprehensive empirical information to better formulate or adjust relevant policies. The predictive results of the study are valuable in helping policy makers foresee the feasibility and effectiveness of the policies according to the contextual conditions of

schools. Since the survey was based on the ELCC (2002) school leadership standards, this study provides a good opportunity to examine the values and feasibility of the revised standards adopted by NCATE in data-driven decision-making. The study may also provide guidance for crafting principals' data-driven decision-making professional development programs. Third, building principals can understand other principals' data-driven decision-making practices, and recognize the advantages and disadvantages of their own practices. Fourth, university administrator preparation program leaders may find the results useful in planning or adjusting their programs for prospective principals in order to meet the needs of educational accountability and change.

Assumptions

The assumptions of this study were:

1. High school principals seek unbiased data and use them with different frequency as they define problems, develop alternative responses, estimate probabilities, and order outcomes in their attempts to make choices that deliver satificing benefits to the school (O'Reilly, 1983; Simon, 1976);
2. High school principals have at least some amount of objective data about the situation of problems available to them;
3. Principals choose the alternative(s) that they think are satisfactory or good enough solutions to the problems based on their analysis and interpretation of those data.

Delimitations and Limitations

This study delimited itself to public high school principals in Nebraska during the 2004-2005 school year. A potential limitation concerns the design of the research methodology. The findings of the study were limited to the extent that the subjects were willing to report their true practices, feelings and beliefs. The credibility of this study may also be influenced by the principals' potential misunderstanding and inadequate knowledge about different types of data when answering the survey questions. A final concern is that the Likert-scales used to measure the frequency of principals' data-driven decision-making practices may not mean the same thing to each respondent.

Definition of Terms

Accessibility of data is the quality or condition of being approached or obtainable regarding data used by the high school principals (Merriam-Webster's Collegiate Dictionary, 1993).

Administrative problem is an issue or a state of difficulty in school administration that needs to be considered, solved or answered. Administrative problems in this study are confined to the specific problems that are stated as the items of the six leadership scales of school vision, school instruction, school organization, collaborative partnerships, moral perspective, and larger-context politics in the Principal Data-Driven Decision-Making Index (see Table 1).

Data are "a set of discrete, objective facts about events", which is the essential raw material for the creation of information (Davenport & Prusak, 1998, p. 2). Within this study, data were confined to (1) student test scores; (2) demographics including

attendance and graduation rates; (3) teachers', students', administrators', and parents' perceptions of the learning environment; and (4) data of school programs and instructional strategies.

Data analysis skill refers to the principals' ability to search information from databases, design and create spreadsheets, and do some basic statistical data analyses.

Data-driven decision-making is the purposeful process of selecting, gathering and analyzing relevant data to define school problems, develop alternatives, estimate outcomes of the alternatives, and choose the preferred alternative (O'Reilly, 1983; Streifer, 2002).

Data quality is the totality of features and characteristics of data that bears on its accuracy, believability, completeness, objectivity, interpretability, and applicability to satisfy given needs (Wang & Strong, 1996).

Decision-making is the process of identifying problems, generating potential alternative solutions, assessing the probabilities that a given alternative will result in a given outcome and developing a preference ordering among outcomes (O'Reilly, 1983; Simon, 1960).

ELCC standards are educational leadership program standards developed by the Educational Leadership Constituent Council (ELCC) (2002) and adopted by the National Council for Accreditation of Teacher Education (NCATE) (2002).

Information is value-added data that are useful in relevant situations (Davenport & Prusak, 1998).

Information behavior is the sum of activities through which information becomes useful (Taylor 1991). Within this study, information behavior specifically

refers to the principal's involvement in processes related to information seeking, requesting, analyzing, interpreting, and using.

Practice is frequently repeated or customary action; habitual performance; a succession of acts of a similar kind; usage; habit; custom (Merriam-Webster's Collegiate Dictionary, 1993).

School size refers to the 2004-2005 high school student enrollment.

School's socioeconomic status is student socioeconomic status, which is measured by the percentage of students who are qualified for free/reduced lunch.

Outline of the Study

Chapter 2 presents a review of literature relevant to data-driven decision-making, the elements of principals' data use environments, and their relationships. Chapter 3 describes the research design, methodology, and procedures that were used for gathering and analyzing the data for the study. Chapter 4 reports the research findings and analyses that emerged from the study. Chapter 5, the final chapter, presents the summary of the study and findings, explores the conclusion drawn from the findings, and discusses the implications.

Chapter 2

Literature Review

For quantitative studies, Creswell (2003) suggests writing a rather complete review of the literature that contains sections about the literature related to major independent variables, major dependent variables and studies that relate the independent and dependent variables. Based on this rationale, this literature review contains three sections of contexts related to data-driven decision-making. The first section incorporates literature about the key contextual elements of data-driven decision-making at school, which contributes to the important independent variables in this study. The second section focuses on the principals' practices of data-driven decision-making that are the dependent variables. The third section presents literature that relates the factors of principals' data use environments to their information behavior of decision-making and the theoretical basis of the study.

School Contexts of Data-Driven Decision-Making

The school contexts in which data-driven decision-making is practiced may affect the acquisition and use of information (O'Reilly, 1983). For instance, the roles of a leader in an organization can affect both the set of information available and one's perspective on the problem (O'Reilly & Pondy, 1997). Although a variety of school contextual factors may be related to principals' practices of data-driven decision-making, three categories of selected factors are presented here: (a) the principal as the subject of data-driven decision-making, (b) school organizational features and (c) principals' administrative problems. These three important domains

construct the fundamental elements of the subject, the organization and the objects in the practices of data-driven decision-making.

Principal as the Subject of Data-Driven Decision-Making

What constitutes principals' behaviors regarding data-driven decision-making? In answering this question, descriptions of demographic and non-demographic characteristics are used for illustration (Taylor, 1991). Literature of three key aspects of principals' non-demographic characteristics including their roles, knowledge and skills, and attitudes, was reviewed for the purpose of understanding what we have known about the behaviors of principals regarding data-driven decision-making,

Leadership roles. With the increased focus on accountability and student success, the role of the principal has transitioned from school manager to the school catalyst for success for all stakeholders (Wilmore, 2002). The pressure for accountability pushes schools to improve in ways that require fundamental paradigm shifts in the nature of schooling, including major changes in the role of the principal and educational leadership (Marsh, 2000). Marsh suggested that one of the dominant shifts is a change from a rule-driven to a results-driven practice. The leadership role of the school principal from the strategic/results-driven perspective focuses on results-indicators or accountability within the tightly-coupled educational and social system. Principals take the priority to help all students meet the high performance standards and to achieve quality goals. Another aspect of the principal paradigm shift is to link management support to educational improvement. The functions of information use become essential in the management support system (Marsh). Data-

driven decision-making originated from results-indicators or accountability provides a new platform for principals to promote all students' success by effectively playing their leadership roles in school vision, instruction, organization, collaborative partnerships, moral perspective, and larger-context politics (ELCC, 2002).

Abilities and skills. It is thought that the current abilities of most school leaders to use data themselves or to facilitate its use by others is extremely limited. Many educational leaders have struggled to incorporate data-driven decision-making into their schools and school systems (McLeod & Creighton, 2001). Few people at schools are adequately trained to gather and analyze data or establish and maintain databases. Educators including school leaders have been trained to be subject-oriented and teaching has been an intuition-based profession.

Educational leadership programs thus are part of the problem. Principal preparation programs commonly present statistical skills that lack practical values in real situations (Bernhardt, 1998; Bracey, 1997; Creighton, 2001a). If data are ever to be used in meaningful ways within schools, educational leadership programs need to prepare administrators who are able to collect and analyze data themselves, but also able to help other educators understand "how they feel about data, what they do (or don't do) with data, why they don't, and how (they can) get into it, get used to it, and end up liking it" (Holcomb, 1999, p. 8). To date, however, most programs have been slow to recognize the unique leadership issues related to data-driven decision-making. They have been even slower in responding to the needs of the schools that receive their graduates for leaders who are knowledgeable about and well-prepared to deal with data collection and analysis (McNamara, 2002). The preservice preparation of

administrators in assessment and data analysis has been weak or nonexistent (National Staff Development Council, 2004).

Attitudes. There are two contradictory aspects of literature regarding principals' attitudes towards data-driven decision-making. Positive attitudes of data-driven decision-making are found in several studies. Although making decisions based on data seems to be painful, it is a reality that school officials take seriously as they become increasingly aware of the importance of data-driven decision-making (Stover, 2003). Principals lead and support the use of data within the school. Principals expect every teacher to use data, and meet with teachers regularly to review their students' achievement data (Armstrong, & Anthes, 2001). A study of six principals in Virginia by Mathews (2002) revealed that principals do not ignore data. They acknowledge it and discuss it. They believe that data play an important role in the process of decision-making. They feel decisions are correctly made based on data and systematic planning can be effectively developed and implemented to address the needs that are exposed by the data.

However, it seems that literature more often indicates the negative side of principals' attitudes of data-driven decision-making. Most school leaders perceive data as an unnecessary burden, not an asset. Bernhardt (1998) insisted that school administrators perceive gathering data as a waste of time. They believe that school data neither simplifies life nor increases a sense of professional efficacy (Doyle, 2003). For many principals, statistics means endless calculations and formula memorization (Creighton, 2001a). Data are something a third party requires the principals to gather about themselves with the expectation that it will be used to

embarrass them down the road (Bernhardt, 1998; Doyle, 2003). Holcomb (1999) also argued that school leaders use little data for decision-making because they believe that data collected would be used to evaluate them and expose their inadequacies, which they usually do not encourage or even fear (American Association of School Administrators (AASA), 2002).

Traditionally, teachers and administrators who use data to solve problems are often perceived as instigators or troublemakers (Petrides & Guiney, 2002). Therefore, principals sometimes react with fear, distrust, and resistance although data analysis revolves around cold and abstract numbers (Lashway, 2002; Thornton & Perreault, 2002). Some school leaders believe that data are collected for mandated compliance reporting (Doyle, 2002; 2003), and data-driven decision-making is another fad that will pass (Thornton & Perreault, 2002). As a result, the term of data-driven decision-making falls trippingly off the tongue, which has become a school-reform mantra that is celebrated but widely misunderstood, and is often ignored or actively feared (Doyle, 2003).

Organizational Features of Data-Driven Decision-Making

A dominating characteristic of any organizational life, which differentiates it from other contexts, is the continual press for uniformity and conformity. This is manifested through the establishment of goals for schools and a hierarchy with control to attain specific goals and with power to insure conformity. Each of these factors is believed to affect information use and decision-making (O'Reilly, 1983).

School improvement as the dominant organizational goal. Under the mandates of NCLB, high schools like other levels of schools across the country must improve.

The top priority of school goals is school improvement. NCLB specifies that states must demonstrate adequate yearly progress (AYP) for statewide measurable objectives that reflect improved achievement by all students. The objectives must be set with the goal of having all students at the proficient level or above within 12 years and must be assessed at the school level. Schools that fail to meet their AYP objective for two consecutive years will be identified for improvement efforts.

All public school districts in Nebraska participate in systematic school improvement, as established in accreditation requirements. Schools accredited by the North Central Association, a regional accrediting agency, also must fulfill a requirement for school improvement. These procedures are intended to improve student learning. Nebraska schools conduct systematic school improvement by using a continuous process based upon the "Nebraska Framework for School Improvement", North Central Association School improvement guides, or other guides (Nebraska Department of Education, 2002).

Nebraska's Comprehensive Plan for School Improvement (Nebraska Department of Education, 2002) states that all students will perform to a high level of achievement, which is an overarching goal for all students in all subject areas at all grade levels. It incorporates the goals and performance indicators for the State under NCLB, the Individuals with Disabilities Education Act (I. D. E.A.), and the core indicators of Career and Technical Education. The State works to integrate more fully the goals and indicators of the various programs under the State goals and establish performance targets for each indicator.

Bureaucratic and professional accountability. Accountability is the engine of principals' practices of data-driven decision-making. "Information is the lifeblood of all accountability mechanisms: one accounts to someone for something, and this accounting gets done by conveying information" (O'Day, 2002, p. 296). Student test data are essential information for an accountability system (Darling-Hammond, 2004). This includes bureaucratic accountability and professional accountability, both of which are regularly used in public school systems.

Bureaucratic accountability proposes that state and district offices promulgate rules and regulations intended to ensure that schooling takes place according to set procedures (Darling-Hammond, 2004). Public school systems tend toward bureaucracy and reliance on rules to control the behaviors of individuals and subunits (Hoy & Miskel, 1996; O'Day, 2002). Schools as collective entities are accountable to the higher levels of the educational systems. "Virtually all states have begun the process of creating standards for student learning, new curriculum frameworks to guide instruction, and new assessments to test students' knowledge. School districts across the country have weighed in with their own versions of standards-based reform, including new curricula, testing systems, accountability schemes, and promotion or graduation requirements" (Darling-Hammond, p. 1047).

Bureaucratic mechanisms are appropriate and workable when standard procedures produce desired outcomes. However, they can be counterproductive when clients have unique needs that require differential responses by those who must make non-routine decisions (Darling-Hammond, 2004). Therefore, another type of accountability, professional accountability is integrated into the school accountability

system. Professional accountability assumes that effective activities rests on professionals acquiring specialized knowledge and skills and being able to apply such knowledge and skills to the specific contexts in which they work (Adams & Kirst, 1999; Darling-Hammond & Ascher, 1991). Professional mechanisms are important when services require complex knowledge and decision making to meet clients' individual needs, but they do not always take competing public goals into account (Darling-Hammond, 2004).

Professional accountability can be seen to apply in promoting principals' practices of data-driven decision making. Each year the Nebraska Department of Education School Improvement Staff works with Educational Service Unit staff to provide statewide professional development opportunities. A series of seminars are provided and designed for principals having responsibility in their local school improvement process. In recent years, seminars have focused on using information and student performance results from the state's assessment system in the school improvement process and plan. Principals learn how to analyze and use student performance information and other assessment data for the purpose of working effectively toward their school improvement goals (Nebraska Department of Education, 2002). In an AASA membership survey in 2000, superintendents overwhelmingly called for principal training on using data because data-driven decision-making requires new knowledge and skills (AASA, 2002).

Uses of power by state and district. Power or hierarchical authority has important ramifications for understanding the utilization of information (Taylor, 1986) because power may be used to define the criteria for decision-making and is

directly related to the ability to obtain resources (Pfeffer, 1992). Hierarchical authority is one way of getting things to happen and hierarchical direction is usually seen as legitimate. From the perspective of power, school districts usually use legitimate power (French & Raven, 1968) to enforce their principals' data-driven decision-making practices. Authority is a basic feature of life in both districts and schools because it provides the basis for legitimate control of principals. Holcomb (1999) affirmed that school boards and accrediting agencies "are requiring schools to demonstrate how they use data to guide decision-making and plan their improvement efforts" (p. 11). For example, principals in Plano, Texas, receive assistance and are held for accountable for their practices of data-driven decision making. They receive mandatory data training and have to know how to use data on their school-based improvement programs and other leadership activities, which is part of their performance appraisal (AASA, 2002).

Armstrong and Anthes (2001) from the Education Commission of the States (ECS) studied the factors, conditions and policies (state and local) that support the use of data for decision-making and school improvement. Case studies were conducted in thirteen schools within six school districts in five states (California, Colorado, Iowa, Maryland and Texas). States mandate that districts collect specific data and report back to the state, requiring the use of data in creating improvement. Districts formulate data-driven comprehensive school-improvement processes and have schools write school improvement plans and measure progress toward those plans. Districts have several central office staff assigned as liaisons to individual schools and principals to oversee their work on data-driven decision-making.

The superintendent plays an important and distinct role in leading principals to use data-driven decision-making. AASA's (2002) study showed that superintendents in some districts illustrate the power of building a data-friendly culture, ensuring that school board members and staff understand their roles and responsibilities, providing the training needed for principals to foster new data skills. They "take every opportunity to show principals that data are not being used to 'get' them, but to improve student learning" (p. 38). They "draw a game plan in clear, bold strokes to help principals understand their important roles in the data system" (p. 42). Superintendents translate the board's vision for the school district into measurable goals based on data, works with principals to crafts plans for meeting goals, celebrate success, evaluate shortcomings and revise plans for improvement based on data (Levesque, Bradby, Rossi, & Teitelbaum, 1998).

However, not all districts embrace data-driven decision-making. After analyzing the uses of data by districts in a Goals 2000 Consortium in Wisconsin, Holcomb (1999) was disappointed to note that leadership role of use of data in these typical districts in a progressive state was still primarily at its initial stage. Less than half of the districts did not have any participants comment on using data at the classroom level, and there was no collaborative school-wide planning for improvement using relevant data.

Administrative Problems for Data-Driven Decision-Making

From a cognitive science perspective, school administration is mostly the administrative behaviors that are problem-based and problem-driven. It is characterized by problem-related choices that principals make. Principals are problem

finders and problem solvers (Davis & Davis, 2003; Glasman, 1994; Leithwood & Steinbach, 1995; Mintzberg, 1980). A problem exists whenever there is a gap between where the solver is (current state) and where he/she wants to be (goal state). Problems at schools in a broad sense are synonymous with tasks (Leithwood & Steinbach). Principals deal with various aspects of problems. They handle pedagogical problems such as disruptive students and instructional improvement issues. They also deal with organizational problems such as allocation of resources and grouping of learners. The principalship is filled with nonpedagogical, nonorganizational problems such as dealing with different groups of outsiders to the schools and involvement with political activities (Glasman). In summary, if school problems are placed in the framework of ELCC (2002) leadership program standards, principals need to deal with all these various problems that fall into the themes of vision, instruction, organization, school-community collaborative partnership, moral leadership, and larger-context leadership.

Drucker (1966) proposed two basic kinds of problems related to generic decisions or unique decisions. Problems of generic decisions are routinely solved by formulaic rules and regulations established by the organization. Problems of unique decisions are problems that are not adequately answered by a general principle or rule. Similarly, Simon (1973) categorized problems into two groups: structured and ill-structured problems. Problems faced by principals tend to exist along a continuum that ranges from highly structured to ill-structured problems or even dilemmas (Leithwood & Steinbach, 1995; Smith & Piele, 1997; Ubben & Hughes, 1997). Most problems vary according to the extent to which they affect all functions of an

organization, the number and layers of individuals within the organization, and the degree to which they represent a particular class (Davis & Davis, 2003).

In a study of interviewing 52 secondary principals, Leithwood and Steinbach (1995) examined the ratio of structured to ill-structured problems encountered by principals. Study results showed that student problems, plant problems, parent problems, community problems, Ministry of Education problems, teacher problems, and school advisor (senior administration) problems have a high incidence of ill-structured problem characteristics. The school routine category has the least ratio of ill-structured problems. If the questions are placed into the frame of the ELCC (2002) program standards, it can be revealed that the leadership standards of moral perspective and larger-context politics have a relatively higher ratio of ill-structured problems. Problems in the leadership standards of instruction, collaborative partnership, and school organizational leadership can be both structured and ill-structured.

As Streifer (2002) found in his research, data-driven decision-making should be used for real problems that school leaders face everyday as they manage and lead their schools toward success. Streifer explored how improved knowledge density can lead to improved decision-making about important school improvement problems by using the advancements of information technologies (IT) in data management and analysis. Knowledge density refers to the richness and enhancement of our knowledge about problems as a result of using decision support tools to explore the enriched data. Our level of thinking about problems becomes more multi-dimensional in an IT environment. The ability to manage more data elements through IT not only

improves efficiency but also directly affects the quality of the inquiry process itself. The more range and depth of the data we have available for analysis, the more deeply we understand a problem, the more knowledge density we have. When this is coupled with the use of proper analytical techniques and appropriate statistics, improved decision-making of different problems is likely to result.

Streifer (2002) also used the term "informed intuition" by Hirshberg to expound the integrated importance of skilled logical analysis of information in making creative decisions. The deeper answers to tough educational problems lie in our ability to conduct data analyses with as much precision as possible, coupled with intuition based on our wisdom and experience. School leaders who possess an ability to make sense and order of the stream of data in addressing the problems effectively derive sense from chaos and lead their organizations toward commonly defined goals. Excellent examples of principals' effective use of data-driven decision-making have been cited by Streifer in solving problems of program evaluation, benchmarking, school improvement programs, equity issues, budgetary control and reallocation, and organizational effectiveness.

The research results and arguments by Streifer (2002) are supported by other research agencies and individuals. AASA (2002) insisted that data-driven decision-making helps school leaders to deal with problems concerning the realization of their schools' vision and purpose. AASA described the following aspects as the functions of data use to solve school problems: measuring student progress, making sure students don't fall though the cracks, measuring program effectiveness, assessing instructional effectiveness, guiding curriculum development, allocating resources

wisely, promoting accountability, reporting to the community, meeting state and federal reporting requirements, maintaining educational focus, and showing trends.

Bernhardt (1998) focused the use of data in solving problems of school improvement. She insisted that principals' data-driven decision-making can make enormous difference in the following problems: (a) replacing hunches and hypotheses with facts concerning what changes are needed, (b) identifying the root causes of problems, (c) assessing needs on important issues, (d) knowing whether goals are being accomplished, (e) determining if schools are on track of their mission, and (f) answering questions about the quality of schools' instruction. Thornton and Perreault (2002) also described the problem aspects of school improvement that school leaders can effectively address by data-driven decision-making: (a) providing students with accurate and timely feedback, (b) documenting improvement in instruction, (c) measuring the success or failure of specific programs, (d) guiding curriculum development, and (e) promoting accountability.

From the motivation perspective, Holcomb (1999) used a continuum to describe the problems that can be solved by data-driven decision-making. At one end of the continuum, data use at school generates extrinsic motivations from compliance approaches such as responding to the public press and answering community questions. The motivating values of data use at the middle part of the continuum includes the problem solving functions such as presenting a complete picture of the school, and testing assumptions about student learning. At the other end of the continuum are the most valuable intrinsic motivations from constructivist approaches

such as satisfying the drive for excellence, demonstrating our belief that we can do a better job and strengthening a culture of efficacy.

Data-Driven Decision-Making Practices

Data-driven decision-making originated from business management models contributes to the foundational activity that underlies NCLB. It is impacting principals who are facing ever-increasing public and policy pressure to improve schools and provide education equity. No principals will be able to escape from the demands of data-driven decision-making (Doyle, 2002; 2003). Principals' practices of data-driven decision-making are becoming part of the culture in some schools. On the other hand, there commonly exist blocks and challenges in other schools, which demonstrates that there is still a long way to go.

Business Management Approaches and their Impacts on School Leadership

The purpose of this section is to review a selection of the research from the fields of business management approaches, which embraces data use for organizational decision-making. The scope of the literature is selective rather than comprehensive, focusing on the most valuable approaches, which contribute the theoretical sources of principals' practices of data-driven decision-making. Data-driven decision-making has been practiced for literally decades for leadership in most business and industry. The use of data for decision making is an essential dimension in the influential management approaches in these three decades such as total quality management (Deming, 1986), learning organizations (Argyris & Schon, 1996; Senge, 1990), and knowledge management (Davenport & Prusak, 1998). All of these

approaches have been and/or are largely impacting the school leadership and stimulate changes in the practices of school leaders' decision making.

Total Quality Management. The effects of the philosophy of Deming's (1986) Total Quality Management (TQM) have been growing and spreading since it was established in the 1950s. The fundamental values of TQM are to improve quality, serve the customer, satisfy customer requirements, encourage employee innovation, provide for the free flow of information, instill pride and teamwork, and create an atmosphere of innovation and continuous improvement. TQM's management philosophy has been applied to educational leadership such as commitment to aims and purpose, a shared common vision, accountability and testing designed to improve education quality, and continuous improvement of schools. The Malcolm Baldridge National Quality Award criteria is one approach that has claimed to incorporate many of the ideas of TQM (Arcaro, 1995).

Using data to make decisions is one of the key ideas in TQM. Deming (1986; 1991) provided a number of statistical models or tools related to the notion of data-driven decision making for quality improvement. Examples are cause and effect analysis, customer needs analysis, customer data gathering, force field analysis, interviewing, benchmarking, and target and goals. Streifer (2002) believed that benchmarking applied to educational improvement is arguably the most important process of data-driven decision-making. Sagor and Barnett (1994) suggested that the TQM leadership in schools develops the cultural norms such as specifically focusing on students, holding high expectations, using data for decision-making, and valuing

collaborative work. Once these cultural changes have been accomplished, the school leader will feel that the work is done.

Organization Learning. Organization Learning (OL) (Argyris & Schon, 1996; Senge, 1990) is a generative process that enhances and extends an organization's ability for creativity. The key rationale of organization learning is to clarify what is important by continually learning how to see the current reality more clearly and developing abilities to move beyond it. "A learning organization is a group of people pursuing common purposes with a collective commitment to regularly weighing the values of those purposes, modifying them when that make sense, continuously developing more effective and efficient ways of accomplishing these purposes" (Leithwood & Aitkin, 1995, p. 41). A shared vision provides the focus and energy for learning and creates commitment. Vision grows out of opportunity to communicate, learn, experiment, be held accountable for results, and most of all to shape the future.

OL is seen as an influential process for accomplishing the goals of school improvement and a strategy that is particularly useful for school leaders who work toward long-term changes (Petrides & Guiney, 2002). OL focuses on resolving problems and on needed high performance results (Marsh, 2000). Schools that are learning organizations will be able to invent or adapt better solutions to perennial educational problems (Fullan, 1993).

DePree (1989) believed that leverage leaders actually focus their efforts in helping people achieve more accurate, more insightful, and more empowering views of reality. Organizational effectiveness depends upon the four elements of people, relationships, information, and communication. The totality of this information is

power. Schools as learning organizations behave in ways that highly participative forms of decision-making are informed by considerable amounts of carefully accumulated data. As schools move from poorer to better quality information for decision-making, organizational learning increasingly will be fostered (Leithwood & Aitkin, 1995). If a school leader can learn to use some data, as well as limited tools to monitor and characterize his or her exceedingly complex surroundings, he or she will make substantive progress toward organizational learning (Baker & Richards, 2004).

Knowledge Management. Knowledge Management (KM) (Davenport & Prusak, 1998) is a concept used to describe the management of information-based knowledge assets within an organization. It is considered key to achieving breakthrough competitive advantage and is currently receiving a lot of attention from business. Definitions of knowledge management are various. One of the widely used is that KM is a discipline that encourages a mutually supported method to create, capture, organize, and use information (Blair, 1999, as cited in Petrides & Guiney, 2002). KM is a process of people's transformation of data, information and intellectual assets into enduring value (Duffy, 2000). Data become information when its creator adds meaning and values by contextualizing, categorizing, calculating, correcting, and condensing the data. Information transforms into knowledge with humans' comparison, consequences, connections, and conversation. In these ecological processes, primary importance is placed on the humans' strategic use of data and information (Davenport & Prusak, 1998).

KM not only practices the management of existing data-based resources within an organization, but also identifies additional information needs throughout the

organization in order to create, capture, and use that information to meet organizational goals by using innovative technology tools (Duffy, 2000). Petrides and Guiney (2002) analyzed examples from schools and found that the knowledge ecological framework can enable schools to examine the plethora of data collected and transform these data into information and knowledge. Through the process of context, accumulation of data, sense making, synthesis, and reflection, data turn into information, and information is transformed and converted into knowledge that is pertinent to educational decision-making within the school as an organization.

Positive Side of Principals' Data-Driven Decision-Making Practices

The need for secondary school administrators to engage in data-driven decision-making has recently received much focus (Leithwood et al., 2001). Several qualitative research studies using case studies and interviews demonstrated that data-driven decision-making is well practiced by principals. Wallace (1985) presented three examples of data analysis successfully used by school leaders for educational improvement in the Pittsburgh (Pennsylvania) Public Schools by focusing on data-driven educational planning and implementation. Armstrong's and Anthes' (2001) case studies reported positive results of secondary principals' practices of data-driven decision-making. Principals lead and support the use of data within the school. Principals in some districts spend time reviewing data with teachers, observing lessons and making decisions on intervention strategies. They are beginning to use classroom student achievement data to mentor teachers and create individual professional development plans.

Mathews' dissertation study (2002) addressed the issues of the principals' response to data of high-stakes tests and their assessment of data-based decisions by interviewing six Virginian middle school principals. Findings indicated that principals responded to the call to use data as a guide for decision-making by devising systematic processes and implementing changes based on data. They used data as a basis for decision-making and do not rely on their own expertise alone in making decisions. They also incorporated collaboration with other professionals for data use in the decision-making process. A majority of the principals interviewed believe that data have a stronger influence on the way they make decisions for their schools. Several principals reported that they had used data for several years to gauge the success of their school improvement plan. The management and assessment of the right data at the right time becomes a critical issue in their decision-making process and adds another dimension to their job.

LaFee (2002) studied the use of data-driven decision-making in four school districts by interviewing the superintendents about data-driven decision-making practices. LaFee insisted that data-driven decision-making is rapidly spread, but is progressing slowly in schools. There is increased interest and efforts by schools in data-driven decision-making. The benefits and values of data-driven decision-making are commonly recognized by school leaders.

Salpeter (2004) who interviewed twenty principals from different states in a study concluded that data-driven decision-making is the buzz phrase of choice for educators including principals for the new decade. Based on the experiences of the twenty principals who practiced data-driven decision-making, Salpeter summarized

the practices of data-driven decision-making in the following aspects: (a) disaggregating student achievement data to identify groups of students who need special intervention, (b) using longitudinal approach to monitor trends, (c) using multidimensional measures to decide complicated decisions with integration of various types of data, (d) building and maintaining data-driven systems, (e) collecting clean and accurate data, and (f) building an information culture.

Studies of data-driven decision-making by Bernhardt (1998), Streifer (2002), and Baker and Richards (2004) were focused on statistical techniques and their applications. Bernhardt described the multiple measures independently and interactively for the four data categories of demographics, perceptions, student learning, and school process by using a real example of one high school in California in making better decisions based on data for school improvement. She categorized the multiple measures into ten levels based on the complexity degree of the questions and the relevant data. Statistical techniques such as snapshots of measures, over time measures, multiple variable measures, interaction measures and their relevant combined measures are used feasibly in the various types of questions for comprehensive school improvement. All these descriptions imply that the use of data is a powerful tool for school improvement.

Examples in Connecticut studied by Streifer (2002) revealed that data-driven decision-making is practiced and applied by school leaders within integrated and sequential school improvement systems. Longitudinal analyses are applied to program evaluation, benchmarking, and setting improvement targets. Techniques of internal and external scanning, and data desegregation analyses are used to identify

equity issues. Data warehousing is used to explore the local landscape and the school organization. Trend analyses and other statistical techniques based on an integrated systems approach are used to enhance principal's decision-making in the school improvement process of planning, management and leadership, personnel evaluation and professional development. School leaders also utilize cost-effectiveness analyses in budgetary control and resource reallocation.

From the perspectives of ecological and systematic school leadership, Baker's and Richards' (2004) case studies found that various practical data-driven methods and knowledge are used by school leaders to understand the schooling context, search for similarities and differences among groups, measure time and change in school, and explore the system dynamics of schooling. Baker and Richards argued that these processes integrated together for value-added measures across organizations through time and set the base for the practice of ecological analysis of the real-world situations for principals. The technical and analytic skills developed by them are an integrated part of a new mental model of school leadership, and an ecological model of leading for understanding complex tasks.

Negative Side of Principals' Data-Driven Decision-Making Practices

Compared to the limited number of studies accepting the good practices of data-driven decision-making, more research informs us that data-driven decision-making practices are not satisfactory and even missing from many schools. School decisions often depart substantially from the rational ideal. Data are not frequently used systematically or are not used well at the school level (Bernhardt, 1998). Many school leaders struggle to incorporate data-driven decision-making into their schools

(McLeod & Creighton, 2001). Although data-driven decision-making has many vocal proponents, it is equally clear that the message has not yet gotten to the front lines of principals (Doyle, 2003).

Davis and Davis (2003) conducted a study using the AIM (Agor Intuitive Management) survey to examine how school principals in California use and experience intuitive decision-making processes when solving administrative problems. Results indicated that 92% of the 221 principals reported that they frequently use intuition to guide them through their most important decisions. Intuition or gut feelings play a primary role in principals' decision-making. Follow-up interviews of six principals reveal that their intuitions came to them most frequently and successfully under stress conditions. Although intuition is used in many different ways during decision-making, it seems to come most often after they apply the analytical thought process.

Davis and Davis (2003) argued that data-driven decision-making and problem solving based on the rational/analytical approach are not adequate and effective in managing complex organizations such as schools. They concluded that intuition as a decision-making tool is frequently used and valued as reliable and indispensable by principals, especially in dealing with uncertainties, ambiguities, and complexities. Davis' and Davis' study results lead us to accept the fact that data-driven decision-making is not frequently practiced by principals. Many school leaders make decisions "by using intuition and shooting from the hip, rather than considering data collection and data analysis" (Creighton, 2001a, p. 52). Traditionally, data have not been the important factors in the ways schools make decisions. The intuition of principals'

advocacy by parents and political interests often has guided decision-making (AASA, 2002).

Based on the four years of experiences of supporting the implementation of standards-based accountability in a set of districts and schools, Jamentz (2001) from WestEd's Western Assessment Collaborative concluded that principals seldom uncovered silver bullets in their data reports. The schools are characterized with ongoing, messy, and ambiguous processes of framing questions, examining and weighing evidence, taking actions and discovering new questions. Similar results are shown in Reeves' (2002) analysis of school examples. He concluded that an astonishing number of principals make critical decisions about curriculum, instruction, assessment, and placement on the basis of information that is inadequate, misunderstood, misrepresented, or simply absent. A limited number of principals use data to influence their decisions although school systems have devoted enormous resources to developing data. School principals commonly underutilize available data (Noyce, Perda, & Traver, 2000).

Reeves (2002) pointed out examples of the incorrect methodology of data use for decision-making. In cases of school leaders' data-driven decision-making, only effect variables such as test scores, attendance, and student safety are usually considered. The cause variables such as professional practices, curriculum availability, and leadership decision, which are also an integral component to understanding educational achievement, are rarely included for analysis. Although data-driven decision-making has become popular, application of data to real decisions remains the exception rather than the rule. Reeves described three myths of data-

driven decision-making: (a) test statistics and psychometrics are technical fields requiring experts for analysis; (b) the central office is responsible for data analysis; and (c) school leaders don't have time for data analysis. Principals' data-driven decision-making is still at a limited level (Bernhardt, 1998) and confronted by many difficulties (LaFee, 2002).

In summary, research indicated both goodness and shortage in principals' practices of data-driven decision-making. However, it seems there are more difficulties and shortcomings rather than smoothness and success at the initial stage of principals' data-driven decision-making. Because the studies cited are mostly qualitative, especially case studies, they cannot be generalized to the experiences of principals' data-driven decision-making practices, which contribute to one of the key research questions in this study.

Impact of Contextual Variables on Principals' Data-Driven Decision-Making

Processing of information is a vital aspect of human behavior and is a critical input to the decision process (Taylor, 1986). Decision-making process is defined as "the conversion of information into action", which suggests an important role for information in the process (McClure, 1978, p. 382). Organizational decision-making, in essence, is information behavior. A person's information behavior is the result of an interaction between who the person is and the environment (Rosenbaum, 1993). "The organizational context in which a decision is taken may affect the acquisition and use of information in decision making" (O'Reilly, 1983, p. 111).

Principals and Information Use for Decision-Making

Sets of people like principals in the same occupation or profession share assumptions and attitudes about the nature of work that impact on their information behaviors. Their education, professional training, occupation, and usual activities contribute to these assumptions and make the uniqueness of their information behaviors (Taylor, 1991).

Demographic variables. Taylor (1991) raised the question whether the differences of information behaviors can be reflected with the differences of the demographic and nondemographic characteristics within each set of people such as high school principals in this study. He suggested that the demographics such as age, gender, and race within the set of people may have an effect on individual informational behaviors. For instance, race may make a difference in restricting the options, and therefore changing the nature of required information for an African American business person. Taylor insisted that these demographic factors may not significantly impact information behaviors, which needs further investigation.

There is a difference between experienced and novice principals in structuring, acquiring, and processing information (Hoy & Miskel, 1996; Lord & Maher, 1991). Hoy and Miskel summarized three reasons that contribute to the difference. First, mental models of experienced and novice principals vary in the type and complexity of stored information. Experienced principals form more complex knowledge structures that contain both problem definition and solutions while novice principals are thought to create separate mental models for problem definition and solution strategies. Second, there are different levels of organizational sophistication

between the mental models of experienced and novice principals. Experienced principals seem more organized, integrated, and structured with critical elements strongly related to the problems. Third, experienced principals are better able to recall information about recent and distant events related to current problems. Experienced principals often rely on nonrational, intuitive processes to make decisions because their expertise and knowledge allow them to recognize immediately key aspects of situations and to move efficiently to solution formulation and implementation (Lord & Hall, 1992). Therefore, they minimize the effortful, analytic processing of information to solve problems (Hoy & Miskel).

However, experienced principals can be highly efficient processors of information only in specific social or task-related areas. Experienced principals are not superior in general, but only in the domains for which they have richly elaborated knowledge structures (Hoy & Miskel, 1996). Experienced principals may also be oriented to using more information in some complex decision-making. Marsh's (1992) research found that school leaders with higher abilities integrate the information management functions with their school leadership activities and are reflective about the use of information in teaching, learning, especially student results.

The demographic variable of education appears to be the most significant factors affecting the individual information behaviors (Taylor, 1991). The studies of principals' data-driven decision-making support this notion. A study by McColskey, Altschuld, and Lawton (1985) on predictors of high school principals' reliance on information indicates that administrators without background in research and

measurement have difficulty in understanding and interpreting the data presented to them. Principals who major in mathematics at college have their advantages in using data for decision-making effectively (Mathews, 2002).

Data analysis skills. Data analysis skills related to principals' education background and training experiences seem to be a critical element affecting of principals' information behaviors of data-driven decision making. The meaningfulness of the information generated by the school system varies in relation to the knowledge and skills of the users. High school principals with higher levels of training in research methods generally rely more on both formal and informal sources of information than those with less data analysis skills (McCloskey et al., 1985). Successful school leaders are skillful at interpreting and conducting research, evaluating programs, and planning for the future (Hoyle, English, & Steffy, 1994).

If principals are to "incorporate the information into their cognitive maps or repertoire of strategies, they must attend to it and must have sufficient knowledge and ability to interpret it" (O'Day, 2002, p. 299). Thus, it is the priority of data-driven decision-making for principals to have basic understanding of applied statistics, data analysis skills, and other necessary computer skills (Thornton & Perreault, 2002). Mathews' study (2002) revealed that the response of principals' data-driven decision-making depends on their comfort and proficiency in the use of data. Principals interviewed credited themselves with having some proficiency in using data as a basis for decision-making. Adequate training for analyzing and using data is essential for principals to carry out data-driven decision-making. "It is important to provide

training and assistance, because data-driven decision-making requires new knowledge and skills" (AASA, 2002, p. 52).

In addressing the question of what data analysis skills are specifically necessary so that school administrators will often link data with their decision-making, Holcomb (1999) suggested that school leaders who use data to improve schools require two sets of skills. One is how to involve others in decision-making and the other is how to use data in appropriate ways to guide their decision-making. Streifer (2002) believed that skills in organizing gathered data into "databases or spreadsheets" "represent the proverbial 'brick wall' that educators hit when trying to conduct data-driven decision-making" (p. 6). How to manipulate the data, readying them for analysis, and using graphing for better representations of the data are critical issues in data-driven decision-making.

Data analysis at school is not mysterious work. The most important school improvement processes do not require sophisticated data analysis or special expertise (Schmoker, 2003). Creighton (2001b; 2001c) believed that most of statistical analyses useful to administrators are not complex. They are more conceptual than requiring complex calculations and can be completed with a basic understanding of mathematics. It is generally simple counts, averages, percentages and rates. However, lack of these skills contributes to one of the key reasons why little data are used and why it is so difficult to generate enough passion to link data with decisions.

Problem Dimensions and Information Use for Decision-Making

Principals' problems arise from the contexts they work in and the roles they play. High school principals generally have problems that can be divided into six

categories: school vision, instruction, organization, school-community collaborative partnership, moral leadership, and larger-context leadership (ELCC, 2002), which define the shape of principals' information seeking and using (Taylor, 1991). Principals' problems also have their own dimensions, each of which illuminates criteria for relevant responses. All these problem contexts shape principals' information seeking and use.

The more significant dimensions of problems are well structured and ill structured (Taylor, 1991). The terms of structured and ill-structured problems denote the amount of relevant knowledge and skill principals possess when encountering a problem and the degree of certainty they have for an effective solution. Structured problems stimulate well-developed responses that demand less conscious thought process while ill-structured problems require more thought and create a significant role for information collection skills (Leithwood & Steinbach, 1995). Well-structured problems can be solved by the application of logical and algorithmic process, and tend to require hard data. Ill-structured problems have variables that are not well understood and require more probabilistic information on how proceed rather than data. Each of these dimensions would appear to have en effect on the kinds of information deemed useful (Taylor, 1991).

"Everyday problems encountered by school leaders are typically very complex in terms of the actual analyses needed to properly address the issue" (Streifer, 2002, p. 4). In a pilot project in Connecticut looking at the use of information technologies in school leadership, Streifer insisted that problems of equity, student achievement, school improvement, and systemic reform are more complex. They require multiple

analyses covering various subcomponents of the problem and a consideration of sub-analysis in the light of the whole before a broad picture of the problem and potential solutions can be understood. One of the keys of data-driven decision-making is the ability to effectively frame problems and develop a "concept map" that breaks the problem into more manageable components for data analysis. "When data become 'more dense' through use of as many pertinent variables as possible, our fundamental understanding of the problem will become enriched, leading us to make better decisions" (Streifer, 2002, p. 8). Based on the case studies of two schools involving in data-driven decision-making in Connecticut, Streifer argued that complex problems require comprehensive data and multiple analysis.

Contradictorily, Davis and Davis (2003) argued that most of the toughest school administrative decisions made by principals are the ones where the computer and lots of quantitative data just are not useful. Instead, most of the difficult decisions are made with a considerable amount of intuitive or gut feelings. Findings of Davis and Davis' (2003) survey study supported this argument that intuition, instead of data-based rational and analytical thinking, seems to emerge when problems are complex, nontransparent, and messy (Agor, 1986; Davis & Davis, 2003; Hogarth, 2001). This study also revealed that the use of intuition depend upon one or more of the following factors: the complexity of the problem, the immediacy of the problem, the characteristics and needs of the participants of involved with the problem, the degree of knowledge about problem facts, and the impact of the decision outcomes.

After Davis and Davis (2003) analyzed 64 secondary principals' narrative comments about their examples of important decisions, nine areas of decisions are

made mostly upon the principals' intuition instead of data-based rational analyses: (a) hiring or firing employees; (b) program, policy, scheduling; (c) conflicts or difficult situations with parents, teachers, or school board members; (d) student conduct or discipline; (e) student safety, welfare, or special needs; (f) communicating and sharing information; (g) personal career choices; (h) staffing and assignments; and (i) employee evaluations. The above order also represents the frequency of the examples raised by the principals from most to least. If we assume that data-based rational/analytical decisions and intuitive decisions are not interacted, it would be reasonable to say that principals rarely or infrequently practice data-driven decision-making in the areas such as hiring or firing employees, developing or monitoring programs and scheduling.

Organizational Operational Features and Data-Driven Decision-Making

The organizational context in which the decision occurs may affect the seeking and use of information in decision-making (O'Reilly, 1983). Taylor (1991) emphasized that the physical and social context in which a principal works affects the way they seek and make use of information. Work setting features such as organizational hierarchical characteristics and access to information may influence attitudes toward information, the types and structures of information required, and the flow of availability of information, which finally affects information behaviors of data-driven decision-making. Armstrong and Anthes (2001) study found that schools successful in using data to support decision-making creates a school structure where data use is embedded in the daily schedule, and staff continue to develop data analysis skills. A case study by Rudy and Conrad (2004) concluded that a supportive

administrative organization structure plays a key role in the practice of data-driven decision-making.

School district requirement and data-driven decision-making. Power as the criteria used in decision-making (Pfeffer, 1992) impacts the organizational contextual influences on use of information for decision-making (O'Reilly, 1983). Principals' willingness to provide opportunities for information acquisition may be tempered by their competitive notions of power (Kirby & Bogotch, 1993). Goldstein, Marcus, and Rausch (1978) described how groups often desire evaluation research to satisfy external demands, but simultaneously are looking for the results to justify established policies and procedures. Decision makers are more receptive to research conclusions that fit nicely into established policies. Based on the research and development laboratories (Pelz, & Andrew, as cited in Taylor 1991), Taylor suggested that what executives emphasize and reward has a great deal to say about the importance of different kinds of information. Information is more likely to be used by decision makers when it is fed into an operating control system, which includes an effective set of incentives (O'Reilly, 1983).

Reichardt's (2000) study used a combination of a literature review and semi-structured interviews with school leaders to examine the role of state policies and programs in facilitating and encouraging the use of data in decision-making at the school level across the state of Wyoming. Wyoming has an extensive policy structure for supporting data-driven decision-making. The state assessment system provides data for principals to discuss, and the accreditation program and its required school improvement plans provide incentives for schools to examine data. The study

identified ways in which the state and district can increase and improve the use of data-driven decision-making in schools. Three clear roles for states and districts in data-driven decision-making emerge from the literature and the interviews: (a) creating a policy structure to support and encourage data-driven decision-making, (b) provision of data, and (c) building capacity to use data.

Interviews with six middle school principals in Virginia showed that the State policy requirements (the Standards of Accreditation) for using data in school improvement have pressured principals to base their decisions on data. These requirements heighten principals' awareness of issues in delving deeper into the data for problem solutions (Mathews, 2002). As principals bear ultimate responsibility for effective data-driven decision-making, the district mandates that they receive data training and make sure that the district has the appropriate policies in place to guarantee the implementation of data-driven improvement (AASA 2002). AASA summarized the key points based on the literature of data-driven decision-making and concluded that a district-wide accountability plan provides for objective measurement of performance and holds principals accountable for results.

Cognitive information processing is influenced by cognitive motivational process (Pintrich, Marx, & Boyle, 1993). A district requirement and support is critical in pointing the way for principals' effective data-informed decision-making, especially in the early stages. Superintendents and school boards both play important, but distinct roles. The support of the school board and superintendent is essential for principals' data-driven decision-making (AASA, 2002; Holcomb 1999; Levesque et al., 1998; Rudy & Conrad, 2004).

School data analysis team and data-driven decision-making. As information is more likely to be used by decision makers if it is summarized, selectively interpreted and organized (O'Reilly, 1983), principals' successful integration of data-driven decision-making into educational strategy requires a team approach (AASA, 2002). A number of research studies have demonstrated evidence that the establishment of an action team responsible for collecting and analyzing data contributes an essential element in the effectiveness of data use at schools. (e.g., Bernhardt, 1998; Noyce et al., 2000; Levesque et at., 1998; Parsons, 2003).

Baker and Richards (2004) emphasized that a team organized for gathering and organizing data use at schools can make principals' data-driven analysis more efficient. "The team's tasks include generating a list of known available data; generating a list of desired data and the likelihood of their availability; identifying potential data sources; deciding on the basic organization of the database; and assigning group members to acquire, clean, and organize the data" (p. 261). Principals who focus the role of data in their decision-making incorporate the knowledge and expertise of other professionals to guide the process rather than embark on their projects alone. They used key individuals to guide their data-driven decision-making and to implement the plans that they devised. The shared data and the cooperative analysis of those data have become the norm (Mathews, 2002).

Thornton and Perreault (2002) suggested that a team approach can avoid or reduce conflicts and fears that may be caused by using data for decision-making. An artful principal who effectively conducts data-driven decision-making develops a small group of teachers to serve as the initial core for implementation of the data-

driven programs. With the establishment of the group, issues of fear are greatly reduced and a stronger support is developed. Errors and false starts can quickly be corrected and progress can continue. Information is more likely to be used by decision makers if it does not lead to conflict among the set of relevant actors (O'Reilly, 1983). Identifying specific staff members who are responsible to enter and maintain each piece of information collected can also result in greater data quality because a clear chain of accountability with appropriate checks can increase the information credibility (McIntire, 2002).

With little or no information, organizational leaders have little or nothing to process and consequently make poor decisions. However, when principals experience information overload, their ability to make good decisions decreases. Several strategies can result in effective use of information for decision-making: using a well-coordinated team approach to share the burden of information processing, hiring knowledgeable and well-trained secretaries or assistants to help with information management and employing communications specialist coordinating, organizing, prioritizing, and limiting the information (Ruff, 2002).

Accessibility of data and data-driven decision-making. Information must be easily accessible by the relevant decision makers before it can have an impact on decision-making. Failure of information availability can result in non-utilization. Information is more likely to be used by decision makers if it is readily accessible (O'Reilly, 1983). The perceived ease of access to information appears in many studies to be the most important variable governing use of information (Gerstenberger & Allen, 1968; O'Reilly, 1979, as cited in Taylor, 1991). Principals should be able to

gain access to the data at schools and in classroom so that they can efficiently conduct data-driven decision-making. It should be a top priority to bring all educational data together for easy access and analysis (Bernhardt, 2003; Streifer, 2002).

Principals interviewed in a study felt that they have an abundance of data available to guide them in their effective data-driven decision-making (Mathews, 2002). However, several studies showed that inaccessibility of proper data or information remains a key block on the road of data-driven decision-making. Streifer's (2002) case studies indicated that easy access to all the data needed is a challenge to exploring "the local landscape, which is defined as the organization over which we have control and for which we have data" (p. 51). Data access and analysis remains a hands-on activity for most schools (Streifer, 2002). Although the primary criterion for data-driven decision-making process is to have the right data available at the right time, it is difficult to find or access the data when they are needed for it usually requires too much time and effort to analyze (Salpeter, 2004). LaFee's (2002) study confirmed that difficult data accessibility resulting from nonsystematic and incompatible data storing and organizing is an important reason why evolution of data-driven decision-making and the paradigm shift is painful.

Based on his experience as a technology director of a suburban New York City school district, McIntire (2002) also insisted that one of the obstacles for data-driven decision-making is that the data, especially high quality data, are not readily available to key decision makers such as principals at schools. Data are not organized and stored in a compatible way. There is a lack of clear and comprehensive data management standards. For instance, the spreadsheets are stored on the clerk's hard

drive. All professional development inquiries have to go through the clerk, who would look at the spreadsheets for answers. Principals could not perform numerous ad hoc queries and test hypothesis. As a result, the ability to use data to make well-informed decisions is severely compromised because school administrators need access to better, more frequently updated data so that they can quickly make appropriate adjustments on programs.

Although data accessibility remains a prerequisite for principals' data-driven decision-making, that is not the sole element that influences the use of information for decision-making. Even when information is abundant and clear, school leaders "stare directly at the information available to them, and then blithely ignore it" (Reeves, 2002, p. 95). Accessibility of data and information does not limit its connotations just within the physical access. It seems to have something to do with the perceived validity and utility of information (Taylor, 1991), which was discussed in the next part of literature review.

Perceptions of Data Quality and Data-Driven Decision-Making

The quality of any data is judged by the user in terms of credibility and usefulness. Information is more likely to be used by decision makers if it is from a source deemed as credible or trustworthy and central to the user's functioning (O'Reilly, 1983). A number of laboratory studies demonstrated that better-quality information is generally associated with improved decision making performance (e.g., Porat & Haas, 1969; Streufert, 1973, as cited in O'Reilly, 1983). How data can be collected in a valid and reliable form is one of the key elements for school

administrators in using data for school administrators' decision-making (Glickman, 1993; Jamentz, 2001; LaFee, 2002).

When data are perceived to be valid and reliable in collections and analysis, data not only confirm what is working well, but also reveal the gaps between the current reality and the shared vision in a way that inspires collective action (Zmuda, Kuklis, & Kline, 2004). Based on a study interviewing 20 principals, Salpeter (2004) insisted that reliability of data remains a challenge for school leaders to conduct data-driven decision-making. It is difficult but essential to develop validation processes, procedures and definitions to deliver reliable data that users trust. The need for data validity and their users' buy-in is critical for data-driven decision-making. If data from tests are to be used in decision-making, then valid and reliable tests need to be written (Ediger, 2002).

Summary

Qualitative-based research has indicated that factors related to principals' practices of data-driven decision-making are various and complex. Factors can be derived from people, work settings, problem nature, and problems solutions (Taylor, 1991). Specifically, they can be any of the following factors: principals' education, experiences, data analysis skills, problem dimension, school district requirement and support, school data analysis team, accessibility of data, and perceptions of data quality.

However, there are two important issues that these studies do not address: (a) what factors are significant, and (b) how the factors interrelate with each other in influencing data-driven decision-making. Data-driven decision-making is an

interactive, multi-faceted, and contextual practice within the school organization. Decision makers, the uses of data, and the context within which decision makers make choices are interrelated. The situational context of information acquisition and use through which decisions are made are critical in understanding organizational decision-making (O'Reilly, 1983).

As a review of the literature has revealed there are three shortcomings in the research of principals' data-driven decision-making. First, because of the limitation of the small or limited samples, these qualitative studies do not have the capacity to address the issue regarding general situations of data-driven decision-making practices of principals as a set of professionals. Second, data are limited to student test scores in most of these studies. Demographics, attendance, graduation rates, school stakeholders' perceptions of the learning environment, and data of school programs and instructional strategies are also useful components of school data (Bernhardt, 1998). Most of these types of data are not integrated into these studies of data-driven decision-making. Third, data-driven decision-making practices are confined to the principals' instructional leadership role. Data-driven decision-making in other leadership roles of school vision, organization, collaborative partnerships, moral perspective, and larger-context politics remain new areas for research.

Chapter 3

Methodology

Overview

This chapter describes the research design and the rationale for it, and identifies the participants targeted for the survey research. It delineates the process of data collection and discusses the instrument used to gather information from the participants. Variables and research questions are reviewed in detail. This chapter concludes with a description of the statistical analysis techniques that were employed.

This quantitative study used original survey instruments to examine Nebraska high school principals' data-driven decision-making practices and to explore the effects of various factors within the principals' work environments on those practices. This study yielded descriptive information and inferential hypotheses used to answer the research questions. The framework for this study was based on the revised ELCC (2002) standards of school leadership adopted by NCATE. The ELCC standards emphasize the values of data-driven decision-making in each dimension of principal leadership.

Research Design and Rationale

This study used a cross-sectional survey research approach. A quantitative approach is based on the ontological assumption that the nature of reality is driven by natural laws and on the epistemological assumption that the inquirer can study the phenomenon without influencing it or being influenced by it. The methodology is deductive with generalizations leading to explanation and prediction. Quantitative approaches are best for research problems that identify factors influencing an

outcome, and those that investigate the best predictors of outcomes (Creswell, 2003). A quantitative study requires collection of reliable, accurate and objective data, and systematic analysis of that data. The cross-sectional approach is utilized to develop a portrait and understanding of a particular phenomenon at a particular time. In this case, the phenomena were the principals' data-driven decision-making practices and the particular time was the spring of 2005. The cross-sectional approach also had the economic advantages of rapid turnaround in collecting data. Surveys are useful tools for collecting information from people to describe and compare their behaviors and attitudes (Fink, 2003a), and probably the best method for gathering original data from a large population (Babbie, 2002), such as the high school principals in Nebraska in this study.

Survey Participants

The population of this study was the individuals with the title of principal in public high schools in the state of Nebraska. According to the Nebraska State Department of Education Directory, there were a total of 289 senior high schools for the 2004-2005 school year in Nebraska. The population for this study is specifically the 289 high school principals in Nebraska. One hundred and eighty three (63.3%) principals participated in this study. Babbie (2002) insisted that a response rate of 50% is adequate for analysis and reporting; a response rate of 60% is good; and 70% is very good.

Data Collection

Data collection for this study combined on-line and mail surveys after receiving approval (see Appendix A) to conduct the study from the Institutional

Review Board (IRB) and Protection of Human Subjects in Clinical Trials at the University of Nebraska (IRB# 052-05-EX). The Internet provides anonymity and ease of use to help principals share their responses, opinions, and ideas. The technology coordinator of the College of Education designed appropriate format for the survey including the cover letter (see Appendix B) and the instrument on the college website. Fifty-four high school principals did not have their email addresses in the email list. Therefore, the cover letter was emailed with an embedded link to the web-based survey to 235 (81.3% of the total) high school principals in March of 2005. Twenty-one emails were bounced back because of delivery failure, leaving 214 successful email deliveries.

In order to increase the return rate, an appreciation and reminder email message was sent to all the survey participants two weeks following the initial email communication, thanking those who may had already participated and encouraging those that had not done so. The reminder email message also included an embedded link to the web-based questionnaire. The researcher undertook a recoding of the rates of return among respondents by using a return-rate graph for calculation of the return rate and analysis of the extent of representativeness of the collected respondents. Two weeks after the reminder email, a letter of support (see Appendix C) from the advisor of this dissertation as the third follow-up email, was sent to all the survey participants in order to encourage more respondents. During the process of the three email requests of surveys, 25 (11.7% of the principals who could receive emails) principals reported that they could not successfully do the on-line survey because of internet and technology problems. Therefore, the online survey population was 189 (65.3%) high

school principals. One hundred and one principals (53.4% of the 189 high principals) successfully responded to the online survey. Of the 101 responses, 93 (92.1%) were usable (responses with more than 6 items missing were eliminated)

The mail survey included three groups of high school principals. The first group was the 75 high school principals whose email addresses were not included in the list or whose email addresses were not correct (those whose first email surveys were bounced back by indicating delivery failure). Seventy-five survey packages including the cover letter, the questionnaires, demographic questions, and returned envelops with stamps were mailed to this group of high school principals in late March. The second group of principals receiving mail surveys were 25 principals who emailed the researcher and reported difficulties in doing the three online surveys. The researcher responded to their emails by thanking them for offering help and sending them mail surveys. Mail surveys were sent to these principals the next day they reported difficulties in doing the on-line survey.

The third group receiving mail surveys, composed of 63 high school principals receiving mail surveys, was selected by the advisor of this dissertation from the list of Nebraska high school principals. This group was also part of the online survey group. A support letter from the advisor thanked the principals who had completed the online survey and encouraged those who had not had a chance to do the survey help in doing so. The support letter was mailed with the survey package to every principal of this group in mid-April of 2005. Of the three groups of 163 mail surveys, a total of 91 principals (55.8%) returned their survey responses to the researcher. Of the 91 responses, 90 (98.9%) were usable (one response with 22-items

of non responses were eliminated, and the other 90 responses were completed with missing answers of less than six items). The combination of online and mail survey generated a total of 183 usable surveys, which provided a overall return rate of 63.3% of the total population of 289 Nebraska high school principals.

Profile Characteristics

Table 1 presents the description of the total 183 subjects' demographic information including their gender, age, ethnicity, educational attainment, length of total school administrative experience, and length of holding the principal position at the current school. The subjects' school demographic information including school size, and school socioeconomic status are also displayed in Table 1.

The majority of the respondents were male high school principals (80.6%). There were more principals in the age group of more than 50 to 62 (43.7%) than in any of the two younger groups. Only 2.2% of the principal respondents were African Americans. No respondents were Asian, Hispanic or Native American high school principals. The great majority of the respondents were Caucasians (97.8%). The lowest level of educational attainment for all principals was the master's degree. Respondents with master's degrees occupied the majority (58.2%) while respondents with doctoral degrees were only 12.1%. Almost one fifth (19.4%) of the respondents had 1 to 5 years of total school administrative experience and 23.4% had more than 20 years of school administrative experience in total. Half of the respondents had been holding the principal position for the range of one to six years. Only 13.1% of the respondents were novice principals (less than one year).

Table 1

Demographic Information of the Survey Respondents and their Schools

		Frequency	*Percent of Total*
Gender (n = 180)			
	Male	145	80.6%
	Female	35	19.4%
Age (n = 179)			
	29 to 40	34	19.0%
	More than 40 to 50	65	36.3%
	More than 50 to 62	80	44.7%
Ethnicity (n = 182)			
	African American	4	2.2%
	Caucasian	178	97.8%
Educational Attainment (n = 182)			
	Ph. D or Ed. D	22	12.1%
	Ed. S (educational specialist)	54	29.7%
	Master's degree	106	58.2%
Length of Total School Administrative Experience (n = 175)			
	Less than 1 to 5 years	34	19.4%
	More than 5 to 10 years	44	25.1%
	More than 10 to 15 years	28	16.0%
	More than 15 to 20 years	28	16.0%
	More than 20 years	41	23.4%
Length of Holding the Principal Position at Current School (n = 175)			
	1 year or less	23	13.1%
	More than 1 to 3 years	46	26.3%
	More than 3 to 6 years	41	23.4%
	More than 6 to 10 years	32	18.3%
	More than 10 years	33	18.9%
School Size (Enrollment) (n = 168)			
	500 or less	108	64.3%
	More than 500 to 1000	24	14.3%
	More than 1000	36	21.4%

(Table 1 continued)

Demographic Information of the Survey Respondents and their Schools

		Frequency	*Percent of Total*
School Socioeconomic Status (Reduced or Free Lunch) (n = 179)			
	20% or less	46	25.7%
	More than 20% to 40%	85	47.5%
	More than 40%	48	26.8%
Schools Having a Team for Data Collection and Analysis (n = 181)			
	Yes	118	65.2%
	No	63	34.8%
Schools Required to Implement Data-Driven Decision-Making by District (n = 179)			
	Yes	131	73.2%
	No	48	26.8%

A majority (64.3%) of the high schools were small-sized (less than 500). Almost half (47.5%) of the respondents reported that the percentage of their students receiving reduced or free lunches was within the range of 20% to 40%. Thirty-five percent of the principals reported that their schools did not have a team responsible for collecting and analyzing data for them while a majority (65.2%) of the high schools had established such teams. Nearly three quarters of the total respondents (73.2%) reported that their school districts required data-driven decision-making at school level.

Instrumentation

The survey instruments used for data collection in this study were the Principal Data-Driven Decision-Making Index (P3DMI) (see Appendix D), the Scales of Data Quality, Accessibility, and Analysis Skills (SDQAAS) (see Appendix E, F,

and G), and demographic information questions (See Appendix H). These instruments served to produce data leading to quantitative or numerical descriptions of the targeted aspects of the study population.

Components

The first section of the survey was the P3DMI developed by the researcher. The P3DMI was made up of the items developed to measure the principals' practices of data-driven decision-making based upon the framework of the ELCC/NCATE (2002) leadership program standards. These P3DMI survey questions included items derived from the six ELCC standards of leadership: (a) school vision, (b) school instruction, (c) school organization, (d) moral perspective, (e) collaborative partnerships, and (f) larger-context politics. The items were designed to measure the frequency of the principals' data-driven decision-making practices on different dimensions of leadership in their schools. The items were defined as "how frequently do you practice this?" with a corresponding 5-choice scale as follows: (1) rarely or never, (2) seldom, (3) sometimes, (4) often, and (5) usually or always. The items in actual survey were presented in random order rather than by categories to insure objectivity.

The Scales of Data Quality, Accessibility, and Analysis Skills (SDQAAS) included three scales of data quality, data accessibility, and data analysis skills. The data quality scale was composed of six survey questions measuring principals' perceptions of data quality on accuracy, objectivity, believability, completeness, and applicability. The data accessibility scale included three items that were developed to measure principals' accessibility of data. All these nine items in the two scales were

selected from the Information Quality Questionnaires (IQQ) (Wang & Strong, 1996), which has been proved to be reliable and valid in business. All the survey questions in these two scales had the following five response choices: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree.

The data analysis skills scale included three items measuring principals' data analysis skills and were developed based upon the suggestions of several high school principals and research. McIntire (2002) argued that school administrators needed to have two areas of skills to become good decision makers. One area was the fundamental spreadsheet and database techniques such as filtering, sorting, and creating pivot tables and histograms. The other area was the fundamental data analysis concepts such as correlation and causation. Principals were asked to rate their comfort level in the three tasks related to data analysis. There were five response choices: (1) very uncomfortable, (2) uncomfortable, (3) somewhat comfortable, (4) comfortable, and (5) very comfortable. In addition, two questions were developed by the researcher to ask whether school districts required data-driven decision-making, and whether the high school established a team for data analysis. All these above five factors were believed relate to the practices of data-driven decision-making based on the literature review (e.g., Armstrong & Anthes, 2001; Bernhardt, 1998; Doyle, 2003; Levesque et al., 1998; Noyce et al., 2000; O'Reilly, 1983; Rudy & Conrad, 2004; Taylor, 1991; Thornton & Perreault, 2002).

The last section of the survey included eight items (see Appendix H) for collecting the demographic data including a principal's age, gender, ethnicity, level of

education, length of total school administrative experience, length of holding the principal position at the current school, school size, and school socioeconomic status.

Content Validity

Measurement of content validity of this study is important because research conclusions based on the structural analysis assume that the measurement is accurately measuring principal's data-driven decision-making practices. Considerable efforts were made to ensure that the survey questions of P3DMI are valid by using the following seven steps.

First, O'Reilly's (1983) "simplified model of decision making process" guided item development for P3DMI. Survey questions developed cover the phases of defining a problem, developing alternatives, estimating probabilities and ordering outcomes in a balanced way. The construction of the survey questions was also based on definitions of data (Bernhardt, 1998; Davenport & Prusak, 1998) and data-driven decision-making (O'Reilly, 1983; Streifer, 2002) found in the literature.

Second, the survey questions of P3DMI were derived directly from the ELCC (2002) leadership program standards. These standards were used as the content criteria for developing survey questions of principals' data-driven decision-making practices in school vision, school instruction, school organization, collaborative partnerships, moral perspective, and larger-context politics. Each survey question was directly traceable to a specific ELCC leadership program standard. These survey questions provided a representative sampling of the data-driven decision-making skills deemed necessary for principals as argued by the ELCC.

The third step in ensuring the content validity is the initial development of P3DMI. A group of 15 secondary school administrators with an average of 14 years of experience in education who were taking the courses of a doctoral program in educational administration at the University of Nebraska at Omaha were asked to help in developing survey questions for the P3DMI in March 2004. After the researcher presented the research proposal and the contexts of the survey including identifying the survey specific purposes and clarifying the relevant terms (Fink, 2003b), the group of school administrators was divided into six panels. Each panel was assigned to develop survey questions for P3DMQ related to one of the following leadership dimensions: school vision, school instruction, school organization, collaborative partnerships, moral perspective, and larger-context politics. Before developing the items, each panel reviewed the following three documents: (a) the definitions of "data" and "data-driven decision-making", (b) the simplified decision making process (O'Reilly, 1983), and (c) the detailed indicators of the ELCC (2002) standard assigned to it.

Fourth, the researcher revised the survey questions initially developed based on ELCC (2002) standards and the literature of data-driven decision-making (e. g., Bernhardt, 1998; Creighton, 2001b; Glasman, 1994; Holcomb, 1999; O'Reilly, 1983; Streifer, 2002; Taylor, 1991; Thornton & Perreault, 2002). Among the 42 survey questions that had been developed, 32 were adopted. The other items were deleted because of their lack of importance or use of unconventional language (Fink, 2003b; Fowler, Jr., 1995). The wording of the adopted 32 questions was refined. Referring to the following two instruments: School Information Collection and Decision-

making (Leithwood & Aitken, 1995) and Data Review Questions (Reeves, 2002), the researcher then developed 28 more items in accordance with the indicators of each of the six ELCC standards.

A fifth step involved a panel review of five professors in the Department of Educational Administration. These professors, including the advisor of this dissertation, taught courses in educational administration based on the framework of ELCC (2002) leadership programs. They examined the survey questions, the overall design, and the wording of each survey question. Improvements in survey structure, content, and item wordings were achieved based on these evaluations.

The sixth step in survey instrument validation was the content validity assessment. "The assessment of content validity typically involved an organized review of the survey content to ensure that it includes everything it should and does not include anything it should not" (Litwin, 2003, p. 33). Four professors teaching data analysis for school leadership, two field experts on school data analysis, and five high school principals were asked to review each of the total 60 survey questions of the six leadership dimensions (school vision, school instruction, school organization, collaborative partnerships, moral perspective, and larger-context politics) and those of the three independent constructs respectively measuring the principals' data analysis skills, principals' perceptions of data quality, and principals' data accessibility. Prior to doing this, all these individuals were informed of the survey contexts and reviewed the definitions of "data" and "data-driven decision-making", and the detailed data-driven decision-making indicators in all the six ELCC standards (2002). All these judges assessed "the extent to which the items in each scale are relevant and

representative examples" (Yukl, Lepsinger, & Lucia, 1992, p. 421) of principals' data-driven decision-making measured by the P3DMI.

The responses drawn from each item were used to target how appropriate, relevant and representative each of the panel members believe the items are by coding each of the items with the following choices: (1) not appropriate, (2) marginally appropriate, and (3) appropriate. Expert review can make the instrument accurate and easily administered while potential respondents can help to guarantee that the items are meaningful and inclusive of all important ideas (Litwin, 2003). Based on the mean scores of each survey questions, the comments and suggestions, 18 survey questions were deleted and the remaining 44 items were modified by the researcher.

The seventh step in survey measurement validation is that the definitions of the two key terms "data" and "data-driven decision-making" were attached to the top of the P3DMI and other survey instruments so that the survey participants understand the defined meanings before they answer the survey questions. The validity and reliability of the P3DMI and other survey questions were also ensured by statistical analysis based upon the following three sections.

Pilot Testing

Thirty-one Nebraska high school principals participated in the pilot study and completed the P3DMI and the Scales of Data Quality, Accessibility, and Analysis Skills (SDQAAS). The purpose of the pilot testing was to help the researcher identify errors, readjust the design, and predict possible problems (Litwin, 2003) with these two instruments. The instruments were mailed to the 60 principals in January 2005. This group of high school principals was sampled in a stratified way to represent

different demographic information. Based on the analysis of the pilot study results, the researcher made appropriate adjustments to the instruments to enhance validity and reliability. To ensure that technological concerns were adequately addressed, the format of the online survey was adjusted based on the results of the pilot testing. This online survey was also piloted with 3 principals who assessed the website and completed the on-line form. They were asked to provide feedback regarding the format, the font size, the online instruction, ease of use, and any technological problems encountered during the completion of the P3DMI.

Internal Consistency Reliability

Internal consistency reliability is the degree of intercorrelation among items in a scale (Yukl et al., 1992) and serves as an evidence of how well the different items measure the same issue (Litwin, 2003). An internal consistency analysis of the pilot testing performing separately for each of the six leadership areas of school vision, school instruction, school organization, collaborative partnerships, moral perspective, and larger-context politics in the standards model and the three independent scales of principals' perceptions of data quality, data accessibility and data analysis skills were applied by calculating Cronbach's alphas. Cronbach's alphas were used to measure the internal consistency reliability of all the multi-itemed constructs for the data collected from all the respondents. The purpose of this analysis was to guarantee a group of items that purports to measure each scale to be at least moderately to highly intercorrelated and indeed clearly focused on that dimension. Based on the statistical analysis, eight survey questions from the 44-item P3DMI were eliminated to raise the reliability coefficient and 36 items remained in the P3DMI. For the same reason, in

the instrument of the Scales of Data Quality, Accessibility, and Analysis Skills (SDQAAS), one item from the data quality scales and one item from the data accessibility scale were also eliminated. The reliability coefficients estimates for all the scales in these two instruments ranged from .76 to .92. Based on the results of the pilot study, the two survey instruments were deemed reliable.

Variables

Independent Variables

The independent variables of the inferential Research Question 2-6 include:

1. In Research Question 2, six principal demographic variables: (a) gender, (b) age, (c) ethnicity, (d) educational attainment, (e) length of total school administrative experience, and (f) length of holding the principal position at current school, and school demographic variables: (a) school size, and (b) school socioeconomic status;
2. In Research Question 3 and 5, two principal nondemographic variables: (a) self-evaluation of his or her data analysis skills, and (b) perceptions of data quality;
3. In Research Question 4, three variables of a school's operational features: (a) school district requirement of data-driven decision-making, (b) establishment of team for data analysis in the school, and (c) accessibility of data.
4. In Research Question 6, the following five variables: (a) a principal's self-evaluation of his or her data analysis skills, (b) a principal's perceptions of data quality, (c) school district requirement of data-driven decision-

making, (d) establishment of team for data analysis in the school, and (e) accessibility of data.

Dependent Variables

The dependent variable in the inferential Research Question 2-6 is the frequency of principals' data-driven decision-making practices of the following leadership dimensions: (a) school vision, (b) school instruction, (c) school organizational operation and moral perspective, and (d) collaborative partnerships and larger-context politics.

Research Questions

This study addressed the following research questions:

1. To what extent do high school principals practice data-driven decision-making in addressing the administrative problems of the leadership dimensions developed by the ELCC/NCATE: school vision, school instruction, school organization, moral perspective, collaborative partnerships, and larger-context politics? Are there any differences in the extent of principals' data-driven decision-making practices among these leadership dimensions?
2. Are high school principals' data-driven decision-making practices significantly affected by the following demographic variables: (a) principal's age, (b) gender, (c) ethnicity, (d) educational attainment, (e) length of total school administrative experience, (f) length of holding the principal position at current school, (g) school size, and (h) school socio-economic status (SES)?

3. Is there a significant relationship between principals' data-driven decision-making practices and their level of data analysis skills?
4. Is there a significant relationship between principals' data-driven decision-making practices and the following school or district operational features: (a) school districts that have a requirement for data-driven decision-making versus those that do not have a requirement for data-driven decision-making, (b) high schools that have a data analysis team in the school versus those that do not have a data analysis team, and (c) level of principals' accessibility of data for decision-making?
5. Is there a significant relationship between principals' data-driven decision-making practices and their perceptions of data quality?
6. Can the following factors significantly predict principals' data-driven decision-making practices: (a) principals' data analysis skills, (b) school districts that have a requirement for data-driven decision-making versus those that do not have a requirement for data-driven decision-making; (c) high schools that have a data analysis team in the school versus those that do not have a data analysis team, (d) level of principals' accessibility of data for decision-making, and (e) principals' perceptions of data quality? If so, which factors are most influential? Are there any variables that do not contribute significantly to the prediction model?

Data Analysis Techniques

Data were analyzed using the SPSS 12.0 software. As a preliminary analysis, mean scores and standard deviations for each the P3DMQ items were calculated to

investigate how often Nebraska high school principals' practiced data-driven decision-making. Descriptive statistics such average mean scores and standard deviations in each of the four leadership constructs: (a) Collaborative Partnerships and Larger-Context Politics, (b) School Organizational Operation and Moral Perspective, (c) School Instruction, and (d) School Vision, were used to examine Research Question 1. The one-way within-subject analysis of variance (ANOVA) was conducted to evaluate the systematic differences among the mean scores on these four leadership constructs. Follow-up paired *t*-tests were used to examine the specific group differences.

For Research Questions 2 and 4, independent *t*-tests were conducted for (a) principals' gender, (b) school district requirement of data-driven decision-making, and (c) establishment of team for data analysis in the school. One-way analyses of variance (ANOVAs) were used to for (a) principal's age, (b) principal's ethnicity, (c) principals' educational attainment level, (d) length of total school administrative experience, (e) length of holding the position principal at current school, (f) school size, and (g) school socioeconomic status. Pearson's product-moment correlation coefficients were calculated for the variable of principals' accessibility of data for decision-making.

For Research Questions 3 and 5, Pearson's product-moment correlation coefficients were calculated to determine if there were significant relationships between data-driven decision-making practices and the two factors of (a) principals' perceptions of the data quality, (b) the principal's self-evaluation of data analysis skills. For Research Question 6, multiple regression analyses were conducted to

determine what factors significantly predicted principals' data-driven decision-making practices. Because a larger number of variables were involved and multiple statistical tests were conducted, a conservative .01 significant level was used for each inferential test to control for Type I error.

Chapter 4

Results

This chapter presents the results of the data analysis in this study. The purposes of this study were to (a) examine the extent to which high school principals apply data-driven decision-making in addressing the ELCC/NCATE standards; (b) determine if the demographics of high school principals and their schools significantly affect their data-driven decision-making practices; and (c) identify factors in the principals' work environments that may affect their data-driven decision-making practices. This chapter first describes the pre-analysis data screening, then presents the results of factors analysis and reliability analysis of the two instruments, and finally provides the results to the research questions in the order that were proposed in Chapter 1.

Pre-Analysis Data Screening

The purposes of pre-analysis data screening were to guarantee the accuracy of the data that had been collected, find the appropriate ways to deal with missing data, assess the effects of outliers if there were any, and assess the adequacy of fit between the data and the assumptions of the statistical procedures used in this study. One mail survey was eliminated because the respondent made multiple selections in the place where only one choice was expected. By using the frequency distributions and descriptive statistics, the range of values in all the variables were examined to ensure that no cases had values outside the range of possible values. Based upon this procedure, three error cases were found among the online surveys and were eliminated.

Among the 101 online responses collected, 6 (6%) responses only completed the first 18 items of the P3DMI without any responses to the other instruments and demographic questions. These six online surveys were eliminated. In all the 183 usable surveys, 24 items had complete data in the P3DMI. The number of missing case data in the other 12 items ranged from one to two out of the 183 respondents. All the items of the Scales of Data Quality, Accessibility, and Analysis Skills (SDQAAS) had missing case data, ranging from one to three out of the 183 respondents in each variable. For all the variables with missing data in the two instruments, the approach of the significant difference test for a single variable was applied for diagnosing the randomness of the missing data. For each variable, two groups were formed, with one group being those observations with missing data, and another group being with the observation with valid values, and significant difference tests were conducted between the two groups on all the variables with missing data. No significant differences in any of the tests were found, indicating that all the missing data were completely at random. The survey responses with missing data on demographic information were eliminated for the relevant statistical analyses.

Graphical examination such as histogram and stem, leaf diagram, box-plots, and normal Q-Q plot were used to visually detect outliers and examine normality of relevant variables and other assumptions for the different statistical tests in this study. Results indicated that there were no outliers and the assumptions of normality were met. This was reasonable because the responses were within the range of 5-five Likert scales and the sample was large enough for most of the variables to keep normally distributed.

Factor Analysis and Construct Reliability

Factor analysis was conducted to determine the underlying constructs for measures on both the 36-item P3DMI and the 12-item SDQAAS. For the P3DMI, principal components analysis was conducted utilizing a varimax rotation. Four criteria were used to determine the appropriate number of components to retain: eigenvalue, variance, scree plot, and residuals. These criteria indicated that the retaining four components should be investigated. Thus, principal components analysis was conducted to retain four components and to apply the varimax rotation. After rotation, the first component accounted for 22.82%, the second for 13.86%, the third for 13.45%, and the fourth for 9.85% of the variance, with a total of 59.98% of the variance.

Component Number 1 included 13 items with positive loadings, which covered the items in practicing data-driven decision-making in the leadership dimensions of both collaborative partnerships and larger-context politics (ELCC (2002) Standard 5 and 6). Therefore, Component Number 1 was named Data-Driven Decision-Making in Collaborative Partnerships and Larger-Context Politics. Component Number 2 included eight items in positive loadings, which covered the items in practicing data-driven decision-making in the leadership dimensions of school organizational operation and moral perspective (ELCC Standard 3 and 4). Therefore Component Number 2 was labeled Data-Driven Decision-Making in School Organizational Operation and Moral Perspective. Component Number 3 included nine items with positive loadings, which covered the items in practicing data-driven decision-making in the leadership dimension of school instruction (ELCC

Standard 2). Therefore, Component Number 3 was named Data-Driven Decision-Making in School Instruction. Component Number 4 included six items with positive loadings, which covered the items in practicing data-driven decision-making in the leadership dimension of school vision. Therefore, Component Number 4 was labeled Data-Driven Decision-Making in School Vision (see Table 2).

Table 2

Rotated Loadings for P3DMI Items

	Loading
Component Number 1: Data-Driven Decision-Making in Collaborative Partnerships and Larger-Context Politics	
I use data to develop effective approaches for school-family partnership.	.788
I use data to measure the effectiveness of outreach to the community.	.773
I use data to suggest appropriate tactics when dialoguing with representatives of diverse community groups.	.761
I use data to determine which community advisory committees should be formed.	.747
I use data to generate approaches with school stakeholders that reflect their concern.	.744
I use data to identify the complex causes of school community concerns.	.738
I use data to gauge the effectiveness of collaborative relationships with the community.	.715
I use data to determine what type of community input should be gained.	.667
I use data to generate alternatives for improving school-community relations.	.624
I use data to mobilize community resources for the benefit of student learning.	.583
I use data to negotiate with political decision makers for the improvement of students' educational opportunities.	.554
I use data to develop effective communication plans.	.534
I use data to understand the larger context of the community, which affects opportunities for students.	.445

(Table 2 continued)
Rotated Loadings for P3DMI Items

	Loading
Component Number 2: Data-Driven Decision-Making in School Organizational Operation and Moral Perspective	
I use data to evaluate my ethical behaviors.	.719
I use data to advocate for policies that promote success for all students.	.665
I use data to promote an environment for improved student achievement.	.642
I use data to insure that staff members are treated fairly.	.628
I use data to monitor instructional practices of the school organization.	.600
I use data to identify safety issues.	.564
I use data to assign human resources in ways that promote student achievement.	.563
I use data to judge my performance in effective management.	.518
Component Number 3: Data-Driven Decision-Making in School Instruction	
I use data to generate approaches to curriculum improvement.	.740
I use data to make recommendations regarding learning programs.	.732
I use data to determine whether specific programs lead to improved achievement.	.657
I use data to plan professional development programs.	.613
I use data to identify problems in student learning.	.526
I use data to predict the outcome of new instructional programs.	.523
I use data to evaluate the instructional efficiency of the school.	.444
I use data to assess learning equity for different populations.	.420
I use data to guide my decision-making in budget formulation focus on student learning.	.411
Component Number 4: Data-Driven Decision-Making in School Vision	
I use data to develop a school vision of learning that promotes the success of all students.	.773
I use data to make decisions in aligning resources with the school vision.	.658
I use data to generate potential elements of a vision statement.	.627
I use data to define possible problems in vision implementation.	.580
I use data to develop alternatives for implementing the vision.	.489
I use data to determine what strategies to use in achieving the goals of advocating for all students.	.451

Principal components analysis was also conducted for the SDQAAS utilizing a varimax rotation. The criteria indicated that the retaining three components should be investigated. Thus, principal components analysis was conducted to retain three components and apply the varimax rotation. After rotation, the first component accounted for 29.92%, the second for 20.89%, and the third for 19.31%, with a total of 70.12% of the variance. Component Number 1 included six items with positive loadings, which were exactly all the items developed to measure principals' perceptions of data quality. Component Number 1 was named Data Quality Scale. Component Number 2 included three items with positive loadings, which were exactly the three items developed for measuring accessibility of data for decision-making. Therefore, Component Number 2 was labeled Data Accessibility Scale. Component Number 3 included three items with positive loadings, which were exactly the items developed to measure principals' data analysis skills. Component Number 3 was named Data Analysis Scale (see Table 3).

Reliability analyses were conducted by using Cronbach's alphas on each of the four components of the P3DMI and the three components of the SDQAAS. The reliability coefficients for the P3DMI's four components of Data-Driven Decision-Making in (a) Collaborative Partnerships and Larger-Context Politics, (b) School Organizational Operation and Moral Perspective, (c) School Instruction, and (d) School Vision were .95, .88, .84, and .88, respectively. The reliability coefficients for the SDQAAS' Data Quality Scale, Data Accessibility Scale, and Data Analysis Scale were .87, .87, and .84, respectively.

Table 3

Rotated Loadings for SDQAAS Items

	Loading
Component Number 1: Data Quality Scale	
Data are reliable.	.830
Data are accurate.	.814
Data are believable.	.809
Data are objective.	.724
Data come from good sources.	.706
Data are applicable to my work.	.623
Component Number 2: Data Accessibility Scale	
Data are easily retrievable.	.876
Data are quickly accessible when needed.	.864
Data are easily obtainable.	.814
Component Number 3: Data Analysis Scale	
Design and create spreadsheets.	.892
Do some basic statistical data analyses.	.846
Search information from databases.	.820

Results Related to the Research Questions

The following section presents and describes the data analysis results of the six research questions. Based upon the factor analysis and construct reliability, the results of the P3DMI are presented into the following four constructs of data-driven decision-making practices in (a) Collaborative Partnerships and Larger-Context Politics, (b) School Organizational Operation and Moral Perspective, (c) School Instruction, and (d) School Vision.

Research Question 1- To what extent do high school principals practice data-driven decision-making in addressing the administrative problems of the leadership

dimensions developed by the ELCC/NCATE: school vision, school instruction, school organization, moral perspective, collaborative partnerships, and larger-context politics? Are there any differences in the extent of principals' data-driven decision-making practices among these leadership dimensions?

The frequency of high school principals' data-driven decision-making practices was measured by the P3DMI. Table 4 presents the descriptive statistics of overall mean scores and standard deviations for each of the four constructs of data-driven decision-making practices in (a) Collaborative Partnerships and Larger-Context Politics, (b) School Organizational Operation and Moral Perspective, (c) School Instruction, and (d) School Vision. Mean and standard deviations of the 36 individual items in the P3DMI is also provided in Table 4. The items of each construct were ranked in an order from the highest to the lowest mean for the purpose of understanding the extent differences of principals' data-driven decision-making practices among the individual items. The survey was answered in a 5-point Likert scale from 1 representing "rarely or never" to 5 representing "usually or always".

The overall mean scores revealed that high school principals sometimes and/or often practiced data-driven decision-making in addressing administrative problems in all the four leadership constructs. The highest overall mean score among these four constructs fell in the leadership dimension of school instruction ($M = 3.99$, $SD = 0.54$). This indicated that the principals used data more frequently in addressing problems or making decisions in school instructional leadership rather than the other leadership dimensions. Over half of the principals (51.4%) reported their mean scores within the range of from four to five, indicating this group of principals used data for

Table 4

Means and Standard Deviations of the P3DMI Constructs and Individual Items

Item No.	*Item*	*M*	*SD*
	Leadership in Collaborative Partnerships and Larger-Context Politics	3.29	0.77
33.	I use data to measure the effectiveness of outreach to the community.	4.16	0.70
27.	I use data to develop effective communication plans.	3.70	0.90
4.	I use data to understand the larger context of the community, which affects opportunities for students.	3.66	0.93
10.	I use data to generate alternatives for improving school-community relations.	3.44	0.92
24.	I use data to identify the complex causes of school community concerns.	3.38	0.95
28.	I use data to determine what type of community input should be gained.	3.32	0.94
18.	I use data to mobilize community resources for the benefit of student learning.	3.28	1.01
16.	I use data to gauge the effectiveness of collaborative relationships with the community.	3.21	0.96
22.	I use data to develop effective approaches for school-family partnership.	3.20	0.94
36.	I use data to generate approaches with school stakeholders that reflect their concern.	3.20	1.02
29.	I use data to negotiate with political decision makers for the improvement of students' educational opportunities.	3.18	1.11
34.	I use data to suggest appropriate tactics when dialoguing with representatives of diverse community groups.	3.00	1.06
35.	I use data to determine which community advisory committees should be formed.	3.00	1.06
	Leadership in School Organizational Operation and Moral Perspective	3.88	0.67
14.	I use data to promote an environment for improved student achievement.	4.28	0.72
30.	I use data to monitor instructional practices of the school organization.	4.18	0.75
12.	I use data to advocate for policies that promote success for all students.	4.10	0.87
8.	I use data to assign human resources in ways that promote student achievement.	3.93	0.82
3.	I use data to insure that staff members are treated fairly.	3.90	1.02
13.	I use data to identify safety issues.	3.83	0.92
15.	I use data to judge my performance in effective management.	3.68	0.86
11.	I use data to evaluate my ethical behaviors.	3.28	1.28

(Table 4 continued)

Means and Standard Deviations of the P3DMI Constructs and Individual Items

Item No.	*Item*	*M*	*SD*
Leadership in School Instruction		3.99	0.54
26.	I use data to identify problems in student learning.	4.24	0.69
7.	I use data to generate approaches to curriculum improvement.	4.23	0.71
6.	I use data to make recommendations regarding learning programs.	4.20	0.73
32.	I use data to determine whether specific programs lead to improved achievement.	4.16	0.70
9.	I use data to plan professional development programs.	4.04	0.78
19.	I use data to evaluate the instructional efficiency of the school.	3.84	0.86
17.	I use data to assess learning equity for different populations.	3.77	0.96
31.	I use data to guide my decision-making in budget formulation focus on student learning.	3.68	0.98
20.	I use data to predict the outcome of new instructional programs.	3.66	0.90
Leadership in School Vision		3.71	0.71
1.	I use data to develop a school vision of learning that promotes the success of all students.	4.01	0.92
2.	I use data to make decisions in aligning resources with the school vision.	3.98	0.87
23.	I use data to determine what strategies to use in achieving the goals of advocating for all students.	3.76	0.90
5.	I use data to generate potential elements of a vision statement.	3.56	1.01
21.	I use data to develop alternatives for implementing the vision.	3.49	0.87
25.	I use data to define possible problems in vision implementation.	3.36	0.96

their decision-making in instructional leadership at a high frequency from "often" to "usually or always". Forty six percent of the principals responded their use of data for decision-making between the frequency levels from "sometimes" to "often". Only 0.6% of the principals rated their responses at the level from "rarely or never" to "seldom".

The frequency of principals' data-driven decision-making practices in the leadership areas of school organizational operation and moral perspective was also

relatively high ($M = 3.88$, $SD = 0.67$). Almost half of the principals (47.8%) marked their frequency level of data use from "often" to "usually or always". Twenty nine percent of the principals responded their use of data for decision-making at the level from "sometimes" to "often".

The overall mean scores of the frequency of principals' data-driven decision-making practices in the leadership dimension of school vision were third ($M = 3.71$, $SD = 0.71$), but close to the overall means of the above two constructs. Forty one percent of the principals reported their responses of data use at the level from "often" to "usually or always". Twenty one percent of the respondents rated their frequency level of data use for decision-making from 'sometimes" to "often".

With comparison to the above three constructs, the principals' data-driven decision-making practices in addressing administrative problems and making decisions were frequently low in the leadership dimensions of collaborative partnerships and larger-context politics ($M = 3.29$, $SD = 0.77$). Only a small percentage of principals (15.2%) reported their frequency level of using data in decision-making for administrative problems was from "often" to "usually or always". Over half of the respondents (52.2%) rated their use of data for decision-making at the frequency level from "sometimes" to "often".

The one-way within-subject analysis of variance (ANOVA) yielded results of significant difference among the mean scores on the four leadership constructs, Wilks' $\lambda = 0.367$, $F(3, 167) = 95.85$, $p < .001$, *Partial* $\eta^2 = .633$. Follow-up paired *t*-tests for the six pairs of differences in the four leadership constructs evaluated at 0.01/6 or 0.002 level using Bonferroni procedure indicated that only one pair, School

Organizational Operation and Moral Perspective versus School Instruction, was non-significant, $t(177) = 2.509$, $p = .013$. The data use frequency of the leadership construct of Collaborative Partnerships and Larger-Context Politics was significantly lower than that of all the other three constructs: (a) School Organizational Operation and Moral Perspective, $t(174) = -14.471$, $p < .001$, (b) School Instruction, $t(175) = -16.112$, $p < .001$, and (c) School Vision, $t(174) = -10.321$, $p < .001$. The data use frequency of the leadership construct of School vision was significantly lower than that of School Organizational Operation and Moral Perspective, $t(176) = -4.328$, $p < .001$, and School Instruction, $t(177) = -7.189$, $p < .001$.

Research Question 2 – Are high school principals' data-driven decision-making practices significantly affected by the following demographic variables: (a) principal's age, (b) gender, (c) ethnicity, (d) educational attainment, (e) length of total school administrative experience, (f) *length of holding the principal position at current school, (g) school size, and (h) school socio-economic status (SES)?*

Principal age. Principals were categorized into three age groups: (a) 29 to 40, (b) more than 40 to 50, and (c) more than 50 to 62. Tests of one-way ANOVAs indicated that there were no statistically significant differences among the three age groups in principals' frequency of data-driven decision making practices on any of the following four constructs: (a) Collaborative Partnerships and Larger-Context Politics, $F(2, 171) = 0.300$, $p = .741$, (b) School Organizational Operation and Moral Perspective, $F(2, 173) = 0.712$, $p = .492$, (c) School Instruction, $F(2, 174) = 0.021$, $p = .979$, and (d) School Vision, $F(2, 174) = 0.345$, $p = .708$. The results showed that principal age did not significantly affect their practices of data-driven decision-

making. Means, standard deviations, and sample sizes of the three age groups are presented in Table 5.

Table 5

Means, Standard Deviations, and Sample Sizes of the Constructs of Data-Driven Decision-Making Practices by Principal Age

Constructs	*Age*	*M*	*SD*	*n*
Collaborative Partnerships and Larger-Context Politics				
	29 to 40	3.20	0.72	33
	More than 40 to 50	3.30	0.74	62
	More than 50 to 62	3.32	0.82	79
School Organizational Operation and Moral Perspective				
	29 to 40	3.79	0.65	34
	More than 40 to 50	3.95	0.53	63
	More than 50 to 62	3.85	0.78	79
School Instruction				
	29 to 40	3.98	0.41	33
	More than 40 to 50	3.99	0.51	65
	More than 50 to 62	4.00	0.62	79
School Vision				
	29 to 40	3.61	0.64	32
	More than 40 to 50	3.72	0.63	65
	More than 50 to 62	3.73	0.80	80

Principal gender. Independent *t*-tests revealed that there were no statistically significant differences between male and female principals in principals' frequency of data-driven decision making practices on any of the following four constructs: (a) Collaborative Partnerships and Larger-Context Politics, $t(173) = 0.437, p = .663$, (b) School Organizational Operation and Moral Perspective, $t(175) = 1.405, p = .162$, (c) School Instruction, $t(176) = 0.990, p = .324$, and (d) School Vision, $t(176) = 1.122, p$

= .263. The results demonstrated that principals' gender did not significantly affect their practices of data-driven decision-making. Means, standard deviations, and sample sizes of the two gender groups are presented in Table 6.

Table 6

Means, Standard Deviations, and Sample Sizes of the Constructs of Data-Driven Decision-Making Practices by Principal Gender

Constructs	*Gender*	*M*	*SD*	*n*
Collaborative Partnerships and Larger-Context Politics				
	Male	3.31	0.76	141
	Female	3.25	0.83	34
School Organizational Operation and Moral Perspective				
	Male	3.85	0.70	142
	Female	4.03	0.58	35
School Instruction				
	Male	3.97	0.55	143
	Female	4.07	0.53	35
School Vision				
	Male	3.68	0.74	143
	Female	3.83	0.63	35

Principal ethnicity. Nearly 98% (n = 178) of the respondents were Caucasians. Only four respondents (2.2%) were African Americans and there were no respondents of other ethnic groups. Therefore, it is not valid to run statistical tests based upon the extremely imbalanced data in sample size.

Principal educational attainment. There were three categories in respondent educational attainment: (a) Ph. D or Ed. D, (b) Ed. S (educational specialist), and (c) master's degree. Tests of one-way ANOVAs showed that there were no statistically significant differences among the three educational attainment groups in principals'

frequency of data-driven decision making practices on any of the following four constructs: (a) Collaborative Partnerships and Larger-Context Politics, $F(2, 174) = 1.912$, $p = .151$, (b) School Organizational Operation and Moral Perspective, $F(2, 176) = 0.658$, $p = .519$, (c) School Instruction, $F(2, 177) = 2.529$, $p = .083$, and (d) School Vision, $F(2, 177) = 1.827$, $p = .164$. The results indicated that principal educational attainment did not significantly affect their practices of data-driven decision-making. Means, standard deviations, and sample sizes of the three groups of different educational attainment are presented in Table 7.

Table 7

Means, Standard Deviations, and Sample Sizes of the Constructs of Data-Driven Decision-Making Practices by Principal Educational Attainment.

Constructs	*Educational Attainment*	*M*	*SD*	*n*
Collaborative Partnerships and Larger-Context Politics				
	Ph. D or Ed. D	3.29	0.77	21
	Ed. S (educational specialist)	3.47	0.85	51
	Master's degree	3.22	0.72	105
School Organizational Operation and Moral Perspective				
	Ph. D or Ed. D	4.03	0.55	22
	Ed. S (educational specialist)	3.85	0.81	53
	Master's degree	3.86	0.62	104
School Instruction				
	Ph. D or Ed. D	4.16	0.54	22
	Ed. S (educational specialist)	4.07	0.63	54
	Master's degree	3.92	0.48	104
School Vision				
	Ph. D or Ed. D	3.92	0.66	22
	Ed. S (educational specialist)	3.77	0.81	53
	Master's degree	3.63	0.66	105

Principal total school administrative experience. Respondents were classified into five groups: (a) less than 1 to 5 years, (b) more than 5 to 10 years, (c) more than 10 years to 15 years, (d) more than 15 to 20 years, and (e) more than 20 years. Tests of one-way ANOVAs showed that there were no statistically significant differences among these four groups in principals' frequency of data-driven decision-making practices on any of the following four constructs: (a) Collaborative Partnerships and Larger-Context Politics, $F(4, 165) = 0.429, p = .787$, (b) School Organizational Operation and Moral Perspective, $F(4, 167) = 0.190, p = .944$, (c) School Instruction, $F(4, 169) = 0.446, p = .775$, and (d) School Vision, $F(4, 168) = 0.433, p = .785$. The results revealed that length of principal total school administrative experience did not significantly affect their practices of data-driven decision-making. Means, standard deviations, and sample sizes of the five groups of different administrative experience are presented in Table 8.

Length of holding the principal position at current school. Respondents were categorized into five groups based upon the years they were in the principal position at the current school: (a) 1 year or less, (b) more than 1 to 3 years, (c) more than 3 to 6 years, (d) more than 6 to 10 years, and (e) more than 10 years. Tests of one-way ANOVAs demonstrated that there were no statistically significant differences among these five groups in principals' frequency of data-driven decision making practices on any of the following four constructs: (a) Collaborative Partnerships and Larger-Context Politics, $F(4, 165) = 0.904, p = .463$, (b) School Organizational Operation and Moral Perspective, $F(4, 167) = 1.173, p = .325$, (c) School Instruction, $F(4, 169) = 2.703, p = .032$, and (d) School Vision, $F(4, 168) = 0.288, p = .885$. The results

Table 8

Means, Standard Deviations, and Sample Sizes of the Constructs of Data-Driven Decision-Making Practices by Principal Total School Administrative Experience

Constructs	*Total Administrative Experience*	*M*	*SD*	*n*
Collaborative Partnerships and Larger-Context Politics				
	Less than 1 to 5 years	3.33	0.75	32
	More than 5 to 10 years	3.30	0.66	43
	More than 10 to 15 years	3.21	0.86	27
	More than 15 to 20 years	3.44	0.86	28
	More than 20 years	3.22	0.75	40
School Organizational Operation and Moral Perspective				
	Less than 1 to 5 years	3.93	0.59	32
	More than 5 to 10 years	3.84	0.72	44
	More than 10 to 15 years	3.85	0.70	28
	More than 15 to 20 years	3.95	0.70	27
	More than 20 years	3.86	0.59	41
School Instruction				
	Less than 1 to 5 years	4.03	0.42	34
	More than 5 to 10 years	3.91	0.59	44
	More than 10 to 15 years	4.07	0.61	27
	More than 15 to 20 years	3.99	0.60	28
	More than 20 years	4.02	0.48	41
School Vision				
	Less than 1 to 5 years	3.77	0.57	32
	More than 5 to 10 years	3.59	0.72	44
	More than 10 to 15 years	3.76	0.81	28
	More than 15 to 20 years	3.75	0.70	28
	More than 20 years	3.73	0.71	41

showed that length of holding the position of principal did not significantly affect their practices of data-driven decision-making. Means, standard deviations, and sample sizes of the five groups of different length of time for being the current school principals are presented in Table 9.

Table 9

Means, Standard Deviations, and Sample Sizes of the Constructs of Data-Driven Decision-Making Practices by Length of Holding the Principal position at Current School

Constructs	*Length of Time*	*M*	*SD*	*n*
Collaborative Partnerships and Larger-Context Politics				
	1 year or less	3.28	0.65	22
	More than 1 to 3 years	3.23	0.81	43
	More than 3 to 6 years	3.49	0.72	41
	More than 6 to 10 years	3.20	0.73	31
	More than 10 years	3.24	0.84	33
School Organizational Operation and Moral Perspective				
	1 year or less	3.96	0.52	22
	More than 1 to 3 years	3.81	0.58	45
	More than 3 to 6 years	4.05	0.64	40
	More than 6 to 10 years	3.79	0.73	32
	More than 10 years	3.80	0.74	33
School Instruction				
	1 year or less	4.01	0.41	23
	More than 1 to 3 years	4.07	0.51	46
	More than 3 to 6 years	4.15	0.53	41
	More than 6 to 10 years	3.80	0.65	32
	More than 10 years	3.88	0.48	32
School Vision				
	1 year or less	3.78	0.46	22
	More than 1 to 3 years	3.69	0.72	45
	More than 3 to 6 years	3.78	0.76	41
	More than 6 to 10 years	3.64	0.84	32
	More than 10 years	3.68	0.62	33

School size. Schools where the respondents worked were classified into three categories based upon their enrollment: (a) 500 or less, (b) 501 to 1000, and (c) more than 1000. Tests of one-way ANOVAs showed that there were no statistically significant differences among these three categories of schools in principals'

frequency of data-driven decision making practices on any of the following four constructs: (a) Collaborative Partnerships and Larger-Context Politics, $F(2, 161) = 0.387, p = .679$, (b) School Organizational Operation and Moral Perspective, $F(2, 163) = 2.881, p = .059$, (c) School Instruction, $F(2, 163) = 4.336, p = .015$, and (d) School Vision, $F(2, 163) = 4.417, p = .014$. The results indicated that school size did not significantly affect their principals' practices of data-driven decision-making. Means, standard deviations, and sample sizes of the three groups of different enrollment are presented in Table 10.

Table 10

Means, Standard Deviations, and Sample Sizes of the Constructs of Data-Driven Decision-Making Practices by School Size

Constructs	*School Size*	*M*	*SD*	*n*
Collaborative Partnerships and Larger-Context Politics				
	500 or less	3.25	0.82	105
	More than 500 to 1000	3.30	0.67	23
	More than 1000	3.38	0.76	36
School Organizational Operation and Moral Perspective				
	500 or less	3.79	0.73	106
	More than 500 to 1000	3.92	0.55	24
	More than 1000	4.09	0.56	36
School Instruction				
	500 or less	3.92	0.58	106
	More than 500 to 1000	3.99	0.45	24
	More than 1000	4.23	0.47	36
School Vision				
	500 or less	3.62	0.74	107
	More than 500 to 1000	3.60	0.69	23
	More than 1000	4.02	0.65	36

However, the p-values of the ANOVA tests for the constructs of School Instruction and School Vision were close to .01. Follow-up Tukey pairwise comparison tests revealed that the difference in frequency of principals' data use in decision making between principals working at schools with enrollment of 500 or less and those working at schools with enrollment of more than 1000 was very close to significant on both constructs of School Instruction ($p = .010$, $d = .59$), and School Vision, ($p = .013$, $d = .67$). The frequency of data-driven decision-making of principals working in schools with enrollment of 500 or less was almost significantly lower than that of those working in larger-enrollment schools with more than 1000 students on both constructs of School Instruction and School Vision. There were no "close to" significant differences in other pairwise comparison groups in either the construct of School Instruction or School Vision.

School socio-economic status (SES). Base upon the reported percentage of students receiving reduced and free lunch, schools where the respondents worked for were divided into three categories: (a) 20% or less, (b) more than 20% to 40%, and (c) more than 40%. Tests of one-way ANOVAs showed that there were no statistically significant differences among these three categories of schools in principals' frequency of data-driven decision making practices on any of the following four constructs: (a) Collaborative Partnerships and Larger-Context Politics, $F(2, 171) = 1.308$, $p = .273$, (b) School Organizational Operation and Moral Perspective, $F(2, 173) = 1.399$, $p = .250$, (c) School Instruction, $F(2, 175) = 2.942$, $p = .055$, and (d) School Vision, $F(2, 174) = 0.116$, $p = .891$. The results indicated that school socioeconomic status did not significantly affect their principals' practices of

data-driven decision-making. Means, standard deviations, and sample sizes of the three groups of different school socioeconomic status are presented in Table 11

Table 11

Means, Standard Deviations, and Sample Sizes of the Constructs of Data-Driven Decision-Making Practices by School Socioeconomic Status

Constructs	*School Socioeconomic Status*	*M*	*SD*	*n*
Collaborative Partnerships and Larger-Context Politics				
	20% or less	3.15	0.76	44
	More than 20% to 40%	3.38	0.76	84
	More than 40%	3.32	0.79	46
School Organizational Operation and Moral Perspective				
	20% or less	3.94	0.57	44
	More than 20% to 40%	3.93	0.66	84
	More than 40%	3.75	0.75	48
School Instruction				
	20% or less	4.00	0.53	46
	More than 20% to 40%	4.08	0.50	85
	More than 40%	3.84	0.61	47
School Vision				
	20% or less	3.73	0.62	45
	More than 20% to 40%	3.74	0.73	85
	More than 40%	3.68	0.78	47

Summary. Based upon the alpha level of .01, all the statistical tests revealed that none of the demographic factors significantly affected the principals' data-driven decision-making practices. However, two statistical tests indicated that their p-values were very close to .01: (a) school size with the principals' data-driven decision-making practices on the construct of School Instruction ($p = .015$), and (b) school size with the principals' data-driven decision-making practices on the construct of School Vision ($p = .014$).

Research Question 3 – Is there a significant relationship between principals' data-driven decision-making practices and their level of data analysis skills?

Tests of Pearson product-moment correlation indicated that there were significant positive relationship between principals' level of data analysis skills and their data-driven decision-making practices on the following three constructs: (a) School Organizational Operation and Moral Perspective, $r(176) = .197, p = .008$ (two-tailed), (b) School Instruction, $r(177) = .304, p < .001$ (two-tailed), and (c) School Vision, $r(177) = .296, p < .001$ (two-tailed). No statistically significant relationship was found between principals' level of data analysis skills and their data-driven decision-making practices on the construct of Collaborative Partnerships and Larger-Context Politics, $r(174) = .155, p = .040$ (two-tailed).

Research Question 4 – Is there a significant relationship between principals' data-driven decision-making practices and the following school or district operational features: (a) school districts that have a requirement for data-driven decision-making versus those that do not have a requirement for data-driven decision-making, (b) high schools that have a data analysis team in the school versus those that do not have a data analysis team, and (c) level of principals' accessibility of data for decision-making?

School district requirement. Independent *t*-tests demonstrated that the frequency of principals' data-driven decision-making practices in school districts that required data-driven decision-making was significantly higher than that of those who worked in school districts that did not require it on all of the following four constructs: (a) Collaborative Partnerships and Larger-Context Politics, $t(172) = 3.279$,

$p = .001$, $d = .58$, (b) School Organizational Operation and Moral Perspective, $t(174) = 3.112$, $p = .002$, $d = .52$, (c) School Instruction, $t(175) = 3.116$, $p = .002$, $d = .55$, and (d) School Vision, $t(175) = 4.415$, $p < .001$, $d = .74$. The effect size estimates (Cohen's d) showed that the differences of data-driven decision-making practices in all the four constructs represent a large and/or substantive effect. The statistical analysis results indicated that whether the school district required data-driven decision-making or not, significantly affected their high school principals' practices of data-driven decision-making. Means, standard deviations, and sample sizes of the two groups (school districts that required data-driven decision-making and school districts that did not require data-driven decision-making) are presented in Table 12.

Table 12

Means, Standard Deviations, and Sample Sizes of the Constructs of Data-Driven Decision-Making Practices by School District Requirement of Data-Driven Decision-Making

Constructs	*School District Requirement*	*M*	*SD*	*n*
Collaborative Partnerships and Larger-Context Politics				
	Yes	3.41	0.76	127
	No	2.98	0.72	47
School Organizational Operation and Moral Perspective				
	Yes	3.97	0.66	128
	No	3.62	0.65	48
School Instruction				
	Yes	4.07	0.54	129
	No	3.78	0.53	48
School Vision				
	Yes	3.84	0.66	130
	No	3.33	0.72	47

School data analysis team. Independent *t*-tests demonstrated that there were no statistically significant differences in the frequency of principals' data-driven decision-making practices between schools that had a data analysis team and those that did not have a data analysis team on any of the following four constructs: (a) Collaborative Partnerships and Larger-Context Politics, $t(174) = 1.288, p = .200$, (b) School Organizational Operation and Moral Perspective, $t(176) = 1.197, p = .233$, (c) School Instruction, $t(177) = 2.465, p = .015$, and (d) School Vision, $t(177) = 2.321, p = .021$. The statistical analysis results indicated that whether a school had a team for data collection and analysis or not did not significantly affect their principals' practices of data-driven decision-making.

However, the *p*-value of the statistical test for the construct of School Instruction was close to the .01 alpha level. The frequency level of principals' data-driven decision-making practices in schools that had a team of data collection and analysis was almost statistically higher than that in schools that did not. Means, standard deviations, and sample sizes of the two groups (schools that had a team and school that did not have a team) are presented in Table 13.

Principals' accessibility of data for decision-making. Tests of Pearson product-moment correlation indicated that there were significantly positive relationships between principals' accessibility of data and their data-driven decision-making practices on all the following four constructs: (a) Collaborative Partnerships and Larger-Context Politics, $r(173) = .264, p < .001$ (two-tailed), (b) School Organizational Operation and Moral Perspective, $r(175) = .233, p = .002$ (two-tailed),

(c) School Instruction, $r(176) = .305, p < .001$, (two-tailed), and (d) School Vision $r(176) = .291, p < .001$, (two-tailed).

Table 13

Means, Standard Deviations, and Sample Sizes of the Constructs of Data-Driven Decision-Making Practices by School Data Analysis Team

Constructs	*School Team*	*M*	*SD*	*n*
Collaborative Partnerships and Larger-Context Politics				
	Yes	3.35	0.76	116
	No	3.20	0.78	60
School Organizational Operation and Moral Perspective				
	Yes	3.93	0.70	115
	No	3.80	0.63	63
School Instruction				
	Yes	4.07	0.55	116
	No	3.86	0.52	63
School Vision				
	Yes	3.80	0.71	117
	No	3.54	0.69	62

Research Question 5 – Is there a significant relationship between principals' data-driven decision-making practices and their perceptions of data quality?

Tests of Pearson product-moment correlation demonstrated that there were significantly significant positive relationships between principals' perceptions of data quality and their data-driven decision-making practices on the following three constructs: (a) School Organizational Operation and Moral Perspective, $r(175) = .217, p = .004$ (two-tailed), (b) School Instruction, $r(176) = .368, p < .001$ (two-tailed), and (c) School Vision $r(176) = .265, p < .001$ (two-tailed). No statistically significant relationship was found between principals' perceptions of data quality and

their data-driven decision-making practices in the construct of Collaborative Partnerships and Larger-Context Politics, $r(173) = .166$, $p = .028$ (two-tailed).

Research Question 6 – Can the following factors significantly predict principals' data-driven decision-making practices: (a) principals' data analysis skills, (b) school districts that have a requirement for data-driven decision-making versus those that do not have a requirement for data-driven decision-making; (c) high schools that have a data analysis team in the school versus those that do not have a data analysis team, (d) level of principals' accessibility of data for decision-making, and (e) principals' perceptions of data quality? If so, which factors are most influential? Are there any variables that do not contribute significantly to the prediction model?

Data-driven decision-making practices in the leadership of Collaborative Partnerships and Larger-Context Politics. Standard multiple regression was conducted to determine whether the following independent variables: (a) principals' data analysis skills, (b) school districts that have a requirement for data-driven decision-making versus those that do not have a requirement for data-driven decision-making; (c) high schools that have a data analysis team in the school versus those that do not have a data analysis team, (d) level of principals' accessibility of data for decision-making, and (e) principals' perceptions of data quality, predict principals' data-driven decision-making practices in leadership dimension of Collaborative Partnerships and Larger-Context Politics. The standard multiple regression was also used to determine which of these factors were most influential, and which did not significantly contribute to the prediction model.

Data screening indicated that the assumptions such as normality, linearity, and homoscedasticity were generally met, which was also supported by examining the residual scatterplots (see Figure 1). Examination of residual scatterplots provides a test of all three of the crucial assumptions for multiple regression (Tabachnick & Fidell, 1996). As figure 1 shows, the points clustered along the horizontal zero line in a well-distributed way, which indicated that the assumptions of normality, linearity, and homoscedasticity were tenable.

Regression results indicated that the overall model significantly predicted principals' data-driven decision-making practices in the leadership dimension of Collaborative Partnerships and Larger-Context Politics, *R Square* = .093, *Adjusted R*

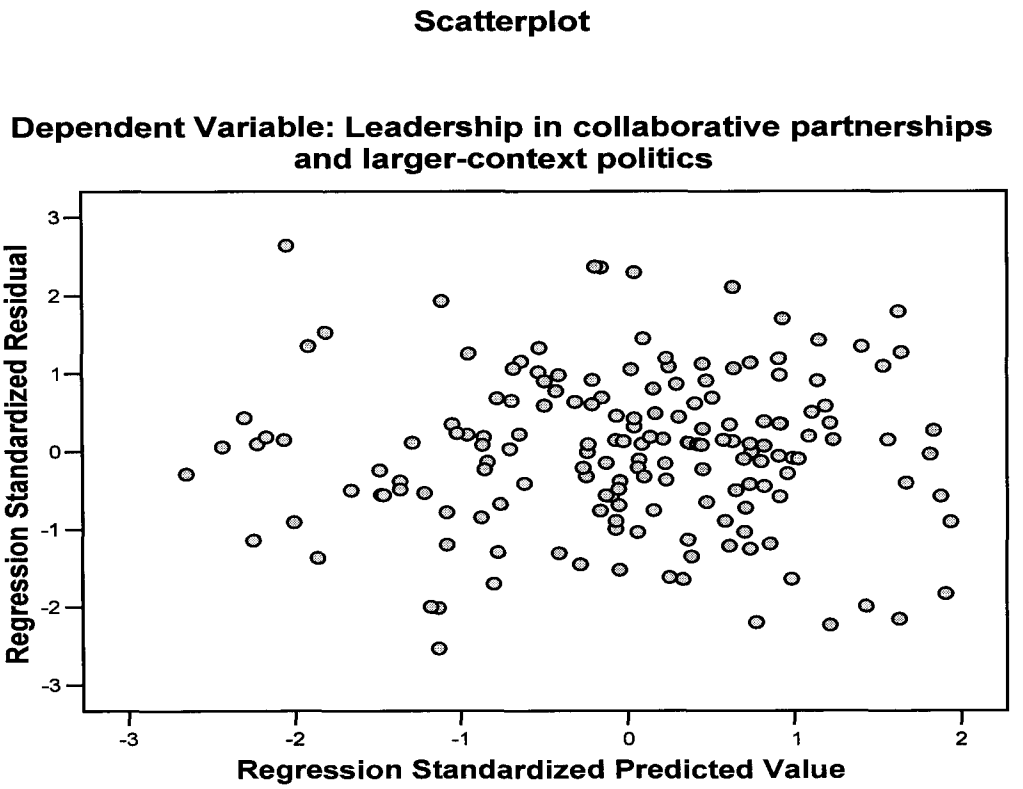

Figure 1. Residuals plots of standardized residuals versus predicted values for leadership construct of Collaborative Partnerships and Larger-Context Politics

Square = .065, $F(5, 163) = 3.332$, $p = .007$. This model accounted for 9.3% of variance in principals' data-driven decision-making in the leadership dimension of Collaborative Partnerships and Larger-Context Politics. All of the tolerance statistics were greater than .1 (see Table 14), which means that there was not a multicollinearity problem among the independent variables. A summary of regression coefficients is presented in Table 14 indicating that only two of the five variables, (a) principals' data accessibility, and (b) school district requirement of data-driven decision-making significantly contributed to the model based upon the .05 alpha level. School district requirement was more influential than principals' data accessibility in contributing to the prediction model. The other three variables: (a) principals' data analysis skills, (b) high schools that have a data analysis team in the school versus those that do not have a data analysis team, and (c) principals' perceptions of data quality, did not significantly contribute to the prediction model.

Table 14

Coefficients for Model Variables of the Leadership Construct of Collaborative Partnerships and Larger-Context Politics

	B	*β*	*t*	*p*	*Bivariate r*	*Partial r*	*Tolerance*
(Constant)	2.293		5.795	<.001			
Data quality	0.008	0.007	0.077	.939	.146	.006	.773
Data accessibility	0.159	0.175	1.982	.049	.247	.153	.716
Data analysis skills	0.065	0.078	0.960	.338	.153	.075	.843
School team	0.011	0.007	0.084	.933	.077	.007	.873
District requirement	0.295	0.171	2.086	.039	.218	.161	.833

Data-driven decision-making practices in the leadership of School Organizational Operation and Moral Perspective. Multiple regression was applied to

determine (a) whether the same five independent variables predicted principals' data-driven decision-making practices in the leadership dimension of School Organizational Operation and Moral Perspective; (b) which of these factors were significantly influential; and (c) which factors did not significantly contribute to the prediction model. The same procedure of data screening and residual scatterplots was conducted to examine the assumptions for the multiple regression. Figure 2 indicates that the points clustered along the horizontal zero line in a well-distributed way, showing that the assumptions of normality, linearity, and homoscedasticity were tenable.

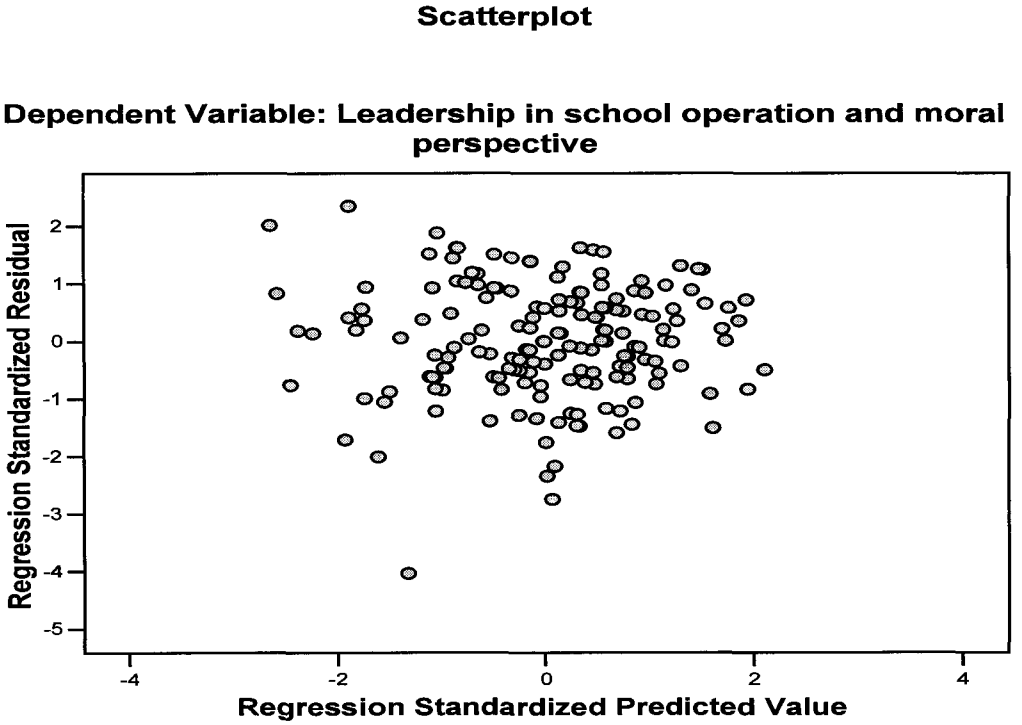

Figure 2. Residuals plots of standardized residuals versus predicted values for leadership construct of School Organizational Operation and Moral Perspective

Regression results indicated that the overall model significantly predicted principals' data-driven decision-making practices in the leadership dimension of School Organizational Operation and Moral Perspective, *R Square* = .098, *Adjusted R Square* = .071, $F(5, 163) = 3.590$, $p = .004$. This model accounted for small percentage (9.8%) of variance in principals' data-driven decision-making practices in the leadership dimension of School Organizational Operation and Moral Perspective. All of the tolerance statistics were greater than .1 (see Table 15), which indicates that there was not a multicollinearity problem among the independent variables. A summary of regression coefficients is presented in Table 15, which shows that only the variable of school district requirement for data-driven decision-making significantly contributed to the model based upon the .05 alpha level. The other four variables: (a) principals' data analysis skills, (b) principals' data accessibility, (c) high schools that have a data analysis team in the school versus those that do not have a data analysis team, and (d) principals' perceptions of data quality did not significantly contribute to the prediction model.

Table 15

Coefficients for Model Variables of the Leadership Construct of School Organizational Operation and Moral Perspective

	B	*β*	*t*	*p*	*Bivariate r*	*Partial r*	*Tolerance*
(Constant)	2.779		8.131	<.001			
Data quality	0.086	0.076	0.895	.372	.196	.069	.765
Data accessibility	0.067	0.085	0.969	.334	.212	.057	.706
Data analysis skills	0.108	0.145	1.794	.075	.208	.138	.833
School team	0.009	0.007	0.085	.933	.058	.007	.892
District requirement	0.249	0.166	2.069	.040	.213	.159	.851

Data-driven decision-making practices in the leadership of School Instruction. Multiple regression was applied to determine (a) whether the same five independent variables predicted principals' data-driven decision-making practices in the leadership dimension of School Instruction; (b) which of these factors were significantly influential; and (c) which factors did not significantly contribute to the prediction model. The same procedures of data screening and residual scatterplots were conducted to examine the assumptions for multiple regression. Figure 3 indicates that again, the points clustered along the horizontal zero line in a well-distributed way, showing that the assumptions of normality, linearity, and homoscedasticity were tenable.

Standard multiple regression results indicated that the overall model significantly predicted principals' data-driven decision-making practices in the leadership dimension of School Instruction, *R Square* = .210, *Adjusted R Squar e*= .186, $F(5, 166) = 8.818$, $p < .001$. This model accounted for 21% of variance in principals' data-driven decision-making practices in the leadership dimension of School Organizational Operation and Moral Perspective. All of the tolerance statistics were greater than .1 (see Table 16), indicating that there was not a multicollinearity problem among the independent variables. A summary of regression coefficients is presented in Table 16. Two of the five variables: (a) principals' perceptions of data quality, and (b) their data analysis skills, significantly contributed to the model. The other three variables: (a) principals' data accessibility, (b) school data analysis team, and (c) school district requirement for data-driven decision-making, did not significantly contribute to the prediction model.

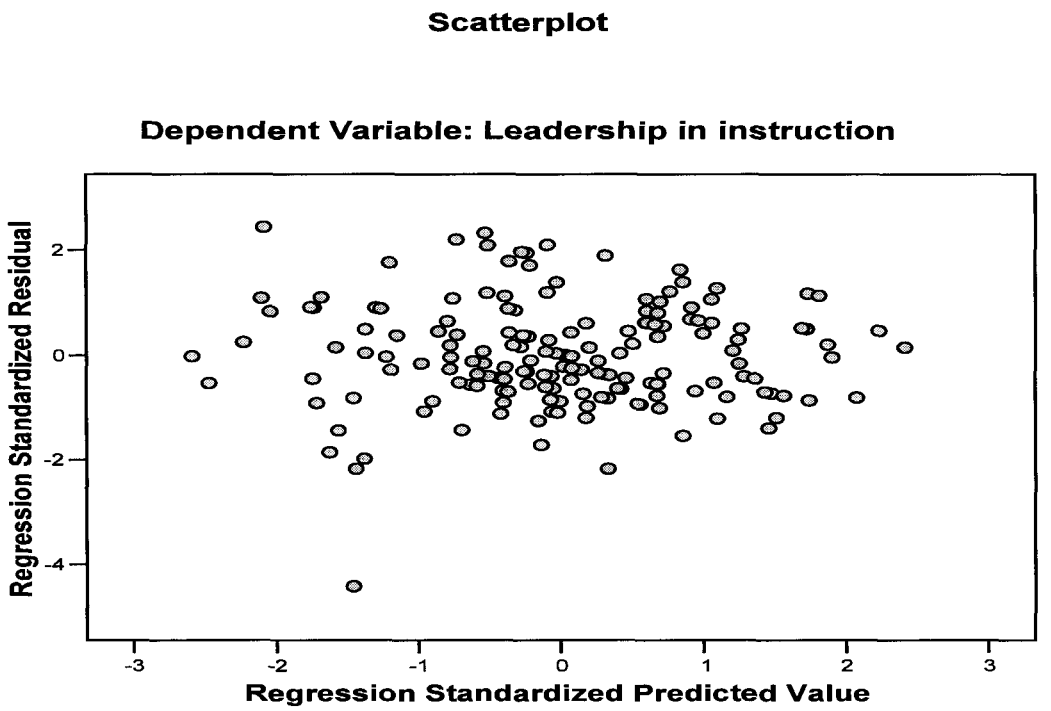

Figure 3. Residuals plots of standardized residuals versus predicted values for Leadership Construct of School Instruction

Table 16

Coefficients for Model Variables of the Leadership Construct of School Instruction

	B	*β*	*t*	*p*	*Bivariate r*	*Partial r*	*Tolerance*
(Constant)	2.408		9.200	<.001			
Data quality	0.208	0.224	2.839	.005	.354	.215	.765
Data accessibility	0.045	0.069	0.848	.398	.293	.066	.711
Data analysis skills	0.136	0.226	3.012	.003	.314	.208	.843
School team	0.109	0.096	1.310	.192	.155	.101	.892
District requirement	0.132	0.107	1.434	.154	.225	.111	.849

Data-driven decision-making practices in the leadership of School Vision.

Multiple regression was applied to determine (a) whether the same five independent variables predicted principals' data-driven decision-making practices in the leadership

dimension of School Vision; (b) which of these factors were significantly influential; and (c) which factors did not significantly contribute to the prediction model. The same procedures of data screening and residual scatterplots were conducted to examine the assumptions for multiple regression. Figure 4 indicates that the points again clustered along the horizontal zero line in a well-distributed way. The assumptions of normality, linearity, and homoscedasticity were tenable.

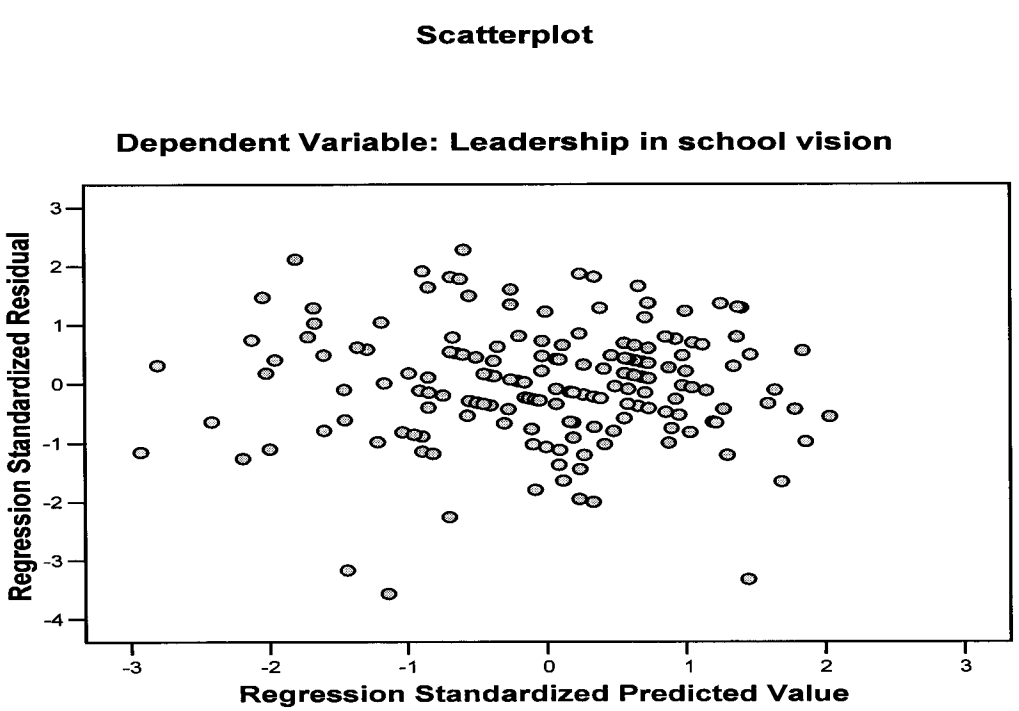

Figure 4. Residuals plots of standardized residuals versus predicted values for Leadership Construct of School Vision

Multiple regression results indicated that the overall model significantly predicted principals' data-driven decision-making practices in the leadership dimension of School Vision, *R Square* = .203, *Adjusted R Square* = .179, $F(5, 166) = 8.444$, $p < .001$. This model accounted for 20.3% of variance in principals' data-driven decision-making practices in the leadership dimension of School Vision. All of

the tolerance statistics were greater than .1 (see Table 17), demonstrating that there was not a multicollinearity problem among the independent variables. A summary of regression coefficients is presented in Table 17. Two independent variables: (a) principals' data analysis skills, and (b) school district requirement of data-driven decision-making significantly contributed to the model. The other three independent variables of (a) principals' perceptions of data quality, (b) principals' data accessibility, and (c) school team of data collection and analysis, did not significantly contribute to the prediction model.

Table 17

Coefficients for Model Variables of the *Leadership Construct of School Vision*

	B	*β*	*t*	*p*	*Bivariate r*	*Partial r*	*Tolerance*
(Constant)	2.070		5.976	<.001			
Data quality	0.098	0.080	0.998	.320	.256	.077	.754
Data accessibility	0.072	0.085	1.032	.304	.276	.080	.711
Data analysis skills	0.191	0.239	3.163	.002	.302	.238	.843
School team	0.096	0.064	0.862	.390	.155	.067	.882
District requirement	0.398	0.243	3.209	.002	.317	.242	.837

Chapter 5

Discussion

The purpose of this study was to examine the extent to which high school principals apply data-driven decision-making in addressing the administrative problems based upon the ELCC/NCATE (2002) standards, determine if the demographics of the principals and their schools significantly affect their data-driven decision-making practices, and identify factors in the principals' work environments that affected their data-driven decision-making practices. The study was delimited to the high school principals of the 2004-2005 school year in Nebraska.

Based upon the framework of the research questions and information use environment (Taylor, 1991), this chapter was begun with interpretations of the results and discussions of how they correspond to other research in the field of data-driven decision-making. Then the second section summarizes the major conclusions of this study. The third section discusses the implications for practice. The forth section discusses theoretical implications. This chapter is concluded with several recommendations for future research in the field of data-driven decision-making.

Interpretations of Results

Extent of Principals' Data-Driven Decision-Making Practices

The self-reported responses reveal an overall picture of the high school principals' use of data in their decision-making. The results of this study indicate that the overall high school principals' frequency level of using data for decision-making transcended "sometimes" and reached "often" with the mean scores of 3.29, 3.88, 3.99, and 3.71, respectively, for the four constructs of school leadership in (a)

Collaborative Partnerships and Larger-Context Politics, (b) School Organizational Operation and Moral Perspective, (c) School Instruction, and (d) School Vision. These descriptive statistics not only provide the evidence that the high school principals in Nebraska practiced data-driven decision-making, but also in an encouragingly high degree, especially in the area of school instruction and student learning. This factual evidence was also confirmed by looking at the percentage of principals who responded that their use of data for decision-making between the high frequency from "sometimes" to "often" was close to and over 50% in the three decision-making constructs of (a) School Organizational Operation and Moral Perspective, (b) School Instruction, and (c) School Vision.

Although it may not be the case that data-driven decision-making is widely practiced among the high school principals, this study reveals the positive situation that a majority of the principals frequently used data to guide their administrative decisions. The results of this study are consistent with the literature on positive side of principals' data-driven decision-making practices (Armstrong & Anthes, 2001; LaFee, 2002; Leithwood et al., 2001; Mathew, 2002; Salpeter, 2004; Wallace, 1985). NCLB (2002), acting as a driving force of data-driven decision-making, has added new responsibilities for states, districts, and schools to exercise more and more efforts in colleting, analyzing and reporting data to prove their bottom line of the educational accountability. With NCLB, data needs to be collected and used to plot progress, to plan and execute instructional interventions, and to report results. In addition, data-driven decision-making holds students, teachers, administrators and school systems

accountable. In the foreseeable future, no educators will be able to escape the demands of data-driven decision-making (Doyle, 2003).

After several years of reinforcement of data-driven decision-making in various efforts such as the areas of policy, research, and practice, it seems that an increased interest in data-driven decision-making is apparent and its practices are encouragingly spread. Principals seem to commonly recognize the benefits and values of data-driven decision-making, and respond to the call in using data as a guide for decision-making during the course of a decade in framing how school would react to the accountability environment. Principals will continue focus their efforts with regard to student achievement and quality teaching and learning, and to seriously evaluate and analyze the existing data in their schools Creighton (2001a).

However, only a small percentage of principals (15.2%) reported that their frequency of using data in decision-making for administrative problems was from "often" to "usually or always" in the construct of Collaborative Partnerships and Larger-Context Politics. This indicates that a majority of principals did not use the data-based rationality, but probably utilized intuition or experiences for administrative decision-making in the leadership dimension of Collaborative Partnerships and Larger-Context Politics. Almost 40% of the principals reported that their frequency level of data use for decision-making in school vision leadership was lower than "sometimes". All these statistics demonstrate that the other side of principals' decision-making that is frequently guided by intuition and experience, but not data-based rationality (AASA, 2002; Davis & Davis, 2003).

The unique approaches to standards, assessment, and accountability in Nebraska with School-based Teacher-led Assessment and Reporting System (STARS) (Nebraska Department of Education, 2002) might contribute to the principals' extensive use of data for their decision-making. In the face of the great nationwide push for standardized testing, Nebraska has established a system that relies on local educators to design their own assessments. Decisions about student learning reside in the classroom and school-based where learning occurs, not in the legislature, the governor's office, or the department of education. Educators, especially principals in local Nebraska school districts are required to do three things: identify clear learning targets (standards), locally measure those targets accurately and appropriately (assessment), and use the assessment data to improve instruction (accountability). The Nebraska STARS provides statewide public accountability, but its first priorities and purpose are student achievement and school improvement. Under this mechanism of education, principals as the top leader in high schools are held accountable for student achievement. Data-driven decision-making as part of school instructional leadership is an effective strategy for their leadership career success.

Effects of Principals' Information Use Environment on Data-Driven Decision-Making Practices

The information behaviors of the decision-making process are the product of the elements of the information use environments (IUE). IUE is defined as the set of elements that affect the flow and use of information into, within, and out of an organization, and determine the criteria by which the value of information will be

judged. The contextual elements of IUE can be grouped into four categories: sets of people, problem dimensions, work settings, and problem resolution assumptions (Taylor, 1986; 1991). The research questions in this study were mostly based upon this theoretical framework.

In this study, the "sets of people" of IUE was high school principals. The variables include the demographic and non-demographic characteristics of the high school principals' data analysis skills. The "problem" of IUE was the four constructs of problems for data-driven decision-making in (a) Collaborative Partnerships and Larger-Context Politics, (b) School Organizational Operation and Moral Perspective, (c) School Instruction, and (d) School Vision. The "work settings" of IUE in this study included the school demographic characteristics and organization operational variables including the school district requirement of data-driven decision-making, school data analysis team, and accessibility of data. There was only one variable in this study that fell into the category of the "resolution of problem" of IUE, that is, principals' perception of data quality. The following section of interpretation of results was organized based upon the framework of IUE.

Principals' demographic characteristics and data analysis skills. None of the principals' demographic factors including (a) principal's age, (b) gender, (c) educational attainment, (d) length of total school administrative experience, and (e) length of time holding the principal position at current school, significantly affected principals' data-driven decision-making practices in any of the four constructs of (a) Collaborative Partnerships and Larger-Context Politics, (b) School Organizational Operation and Moral Perspective, (c) School Instruction, and (d) School Vision. In

other words, there were no significant differences in principals' data-driven decision-making practices between or among the different level groups of principals' age, gender, educational attainment, administrative experience, and length of holding the principal position at current school. These results support Taylor's (1991) proposition that in most cases, demographic characteristics of sets of people do not really have an effect in significant ways on their informational behaviors.

Taylor (1991) suggested that of all the demographic variables, education appears to be the most significant one if there are some effects on information behaviors. Level of education may have some bearing because of certain needed skills such as action research and statistical analysis skills. This study reveals non-significant differences in data-driven decision-making by principals' educational attainment, but the mean scores of the group of principals with doctoral degrees was the highest in the three constructs of (a) School Organizational Operation and Moral Perspective, (b) School Instruction, and (c) School Vision. A majority of principals with doctoral degrees should have much stronger background in research skills than those with lower academic degrees. However, formal recognition of problems, and resultant information behaviors, are not necessarily learned through formal education (Taylor). Therefore, this finding lends supports to the suspicion with the notion that principals with higher educational attainment would use more data for their decision making in a rational/analytic way.

Although there were no statistically significant differences, principals with more experience of leadership in the current school tended to use data for decision-making slightly less frequently than those with shorter length of time holding the

position of principals. Experienced or expert principals are assumed to rely on well-organized and highly developed knowledge structures, which are based on intuition to solve their problems and make decisions (Lord & Maher, 1991). Principals with experts' capacities recognize immediately key aspects of situations and use their knowledge and understanding to move efficiently to solution formulation and implementation (Lord & Hall, 1992).

The demography of educators such as age, gender, ethnicity, educational level, and length of services is the composite aggregation of the characteristics of the individual educators at school organizations. It has been used to describe and account for the form of school organizations. The demographic effects on various school education outcomes and processes such as student achievement and educator performance have been widely studied in educational research, which has provided valuable evidence for various education program designs and professional training development. If demography is a significant explanatory factor in school organizational analysis, then it becomes theoretically and practically important to understand the factors that are associated with differences in demographic distributions across contexts (Pfeffer, 1983).

It is often important and useful theoretically and practically to discover that there is no demographic effect in some educational phenomena. The study result that there were no gender effects in principals' data-driven decision-making provides evidence to rethink the long-standing stereotypes or traditional mindset that female leaders would use more gut feelings or intuition and less rationality based upon data in decision making than male counterparts. This finding was also different from that

of the study that females are more intuitive than males (Hogarth, 2001). This study also offers evidence for diversified research results that school leaders with more leading experience and/or with older age would make decisions based more on intuition rather than on data than the inexperienced school leaders (Davis & Davis, 2003; Hoy & Miskel, 1996). In practice, this study can inform policy and decision makers who are in change of promoting principals' data-driven decision-making that they do not need to consider much on demographic factors in making policies and designing professional training programs.

Principals' non-demographic factors in this study only included principals' data analysis skills. Data analysis skills were found to be significantly positively related to their data-driven decision-making practices in the three constructs of (a) School Organizational Operation and Moral Perspective, (b) School Instruction, and (c) School Vision, but not significant in the construct of Collaborative Partnerships and Larger-Context Politics. However, there still existed a slightly positive relationship between data-driven decision-making and principals' data analysis skills in the construct of Collaborative Partnerships and Larger-Context Politics. Principals' level of data analysis skills generally significantly affects their use of data for decision-making in most of the leadership dimensions. The higher level a principal's data analysis skills, the more frequently he/she would use data for their decision-making.

The finding that data analysis skills were generally related to data-driven decision-making not only supports the literature in the field of education (AASA, 2002; Mathews, 2002; O'Day, 2002; Thornton & Perreault, 2002), but also is

consistent with the findings of human information processing (Schroder, Driver, & Streufert, 1967; Streufert, Suedfeld, & Driver, 1965). Individuals with higher data analysis skills tend to process a higher measure of cognitive complexity, and therefore, are likely to process more information in complex decision situations than those who had low ability of cognitive complexity. The skills of searching information, designing and creating spreadsheet, and basic statistical analysis equipped the principals with more complex cognitive structures, which made them better able to integrate information acquired into the decision-making process (Streufert et al.).

Principals are limited in the amount of information they can handle in a decision situation. However, with the skills of data analysis, principals as decision makers can process large amounts of data without consuming a great deal of time and are able to use real-time information that is relevant and useful for decision-making. From this perspective, it is natural and reasonable that data analysis skills as the tools for information processing are strongly related to the data-driven decision-making practices.

In summary, principals' personal factors included in this study had two categories: demographic factors (age, gender, educational attainment, total school administrative experience, and length of holding the principal position at current school) and non-demographic factor (data analysis skills). None of the demographic factors was found to affect the frequency of principals' data-driven decision-making practices. Data analysis skill was generally found to be significantly related to data-

driven decision-making in a positive way. These results mostly support the past research.

Administrative problem dimensions. Taylor (1991) asserted that "each of the definable IUEs has a discrete class of problems, spawned by its particular setting and by the exigencies of its profession, occupation, or life style" (p. 225). Accordingly, high school principals' administrative problems can be divided into four categories based upon the factor analysis: (a) Collaborative Partnerships and Larger-Context Politics, (b) School Organizational Operation and Moral Perspective, (c) School Instruction, and (d) School Vision. The overall mean scores indicate that the principals used data in a high frequency in problems solving and decision-making in the three constructs of (a) School Instruction ($M = 3.99$), (b) School Organizational Operation and Moral Perspective ($M = 3.88$), and (c) School Vision ($M = 3.71$). Data were used the most frequently in School Instruction dimension of problems, which reached the high frequency level of "often" and "usually or always". Data were used the least frequently in the administrative problem dimensions of Collaborative Partnerships and Larger-Context Politics ($M = 3.29$), which was significantly lower than the other three constructs in overall mean scores.

There existed the significant systematic differences among the mean scores on the four leadership constructs. Data use frequency of both constructs of School Instruction and School Organizational Operation and Moral Perspective was significantly higher than that of both constructs of School Vision and Collaborative Partnerships and Larger-Context Politics. On the other hand, data use frequency of the construct of School Vision was significantly higher than that of the construct of

Collaborative Partnerships and Larger-Context Politics. The percentage of data use frequency and the mean scores of individual items also support these results. As instructional leaders, school organizational leaders, and visionary leaders, principals use more data for decision-making. As leaders in school-community partnerships and political leaders, principals use less data for their decision-making.

This finding supports the notion that a high school principal's problems emerging in the school context define the shape of his/her information seeking and use. Problem dimensions that are the characteristics and nature of the typical problems faced by the particular set of people (principal) can have an effect on their data use (Taylor, 1991). Data were most frequently used by principals in addressing problems in curriculum, teaching, and learning at school, which reflects the realities that data-driven decision-making was primarily and/or urgently demanded with the purposes of improving student achievement in the accountability movement, especially with the passage and implementation of NCLB (2002). The use of data is focused in solving problems of school improvement (Bernhardt, 1998; Thornton & Perreault, 2002). Data-driven decision-making is mostly referred in a narrow sense to using data in solving problems and making decisions of school instruction and student learning, which can be shown in both practice and research. Principals who assume the role of instructional leaders should value information and can be more likely to gather and rely on information in making decisions (McColskey et al., 1985).

On the contrary, there is very little theoretical or practiced-based literature about data-driven decision-making in addressing administrative problems in school-community relations and collaborative partnerships. Policy requirements about this

are also rare. Therefore, this reasonably supports the finding that principals least frequently practiced data-drive decision-making in the leadership construct of Collaborative Partnerships and Larger-Context Politics. Problems act as surrogates of the information use environment, and because they encapsulate enough of the more salient demands of the use of environment, problem dimensions contribute to the information needs and use in decision-making (MacMullin & Taylor, 1984).

Another aspect of problem dimension that Taylor (1991) proposed is to define information need and serve as criteria by which the relevance of information to a problem will be judged. MacMullin and Taylor (1984) identified 11 problem dimensions as lying on a continuum that would appear to have an effect on the kinds of information deemed useful. Among these dimensions, the most significant are well structured/ill structured, and complex/simple. Structured problems demand less conscious thought process while ill-structured problems require more thought and create a significant role for information collection skills (Leithwood & Steinbach, 1995). This proposition is supported by the results of the study that principals most frequently used data for decision-making in student achievement, school improvement, and equity, which were believed to be complex or ill-structured problems by Streifer (2002). From the perspective of the individual items of the P3DMI, the mean scores of items related to the theme of student learning were mostly rated high in frequency. Good examples are as follows: (a) I use data to identify problems in student learning ($M = 4.24$, $SD = 0.69$), (b) to generate approaches to curriculum improvement ($M = 4.23$, $SD = 0.71$), (c) to make recommendations regarding learning programs ($M = 4.20$, $SD = 0.73$), (d) to develop a school vision of

learning that promotes the success of all students ($M = 4.01$, $SD = 0.92$), (e) to promote an environment for improved student achievement ($M = 4.28$, $SD = 0.72$), (f) to monitor instructional practices of the school organization ($M = 4.18$, $SD = 0.75$), and (g) to advocate for policies that promote success for all students ($M = 4.10$, $SD = 0.87$).

If the proposition that administrative problems solved with less data are well-structured problems, the results of the study would suggest that the administrative problems in school-community relations and larger-context politics tend to be less ill-structured and less complex problems for the principals because principals used data the least frequently. This is not only demonstrated by the lowest overall mean scores, but also by the individual items with lower mean scores. Following are some of the examples: (a) I use data to gauge the effectiveness of collaborative relationships with the community ($M = 3.21$, $SD = 0.96$), (b) to develop effective approaches for school-family partnership ($M = 3.20$, $SD = 0.94$), (c) to generate approaches with school stakeholders that reflect their concern ($M = 3.20$, $SD = 1.02$), (d) to negotiate with political decision makers for the improvement of students' educational opportunities ($M = 3.18$, $SD = 1.11$), (e) to suggest appropriate tactics when dialoguing with representatives of diverse community groups ($M = 3.00$, $SD = 1.06$), and (f) to determine which community advisory committees should be formed ($M = 3.00$, $SD = 1.06$).

However, some research literature and propositions insisted that most of the difficult decisions posed by ill-structured problems are made with a considerable amount of intuitive or gut feelings instead of the rational/analytical approach based

upon data analysis (Agor, 1986; Davis & Davis, 2003; Hogarth, 2001). If this proved to be true for the principals, the different results of data use in different leadership dimensions found by this study would indicate that the administrative problems in school-community collaborative partnerships and lager-context politics were more complex and ill-structured problems for the principals while other administrative problems tended to be less ill-structured and complex. The study conducted by Leithwood and Steinbach (1995) did show that parent problems, community problems, Ministry of Education problems, and school advisor (senior administration) problems have a high incidence of ill-structured problem characteristics. However, the topic that which proposition is true for the majority of high school principals in Nebraska is rather complicated and very interesting, which needs more delicate and deeper studies in order to offer a persuasive answer.

Finally, it is interesting and noteworthy that the finding of this study was somewhat different from the Davis' and Davis' (2003) study on the areas of decisions that are made mostly upon the principals' intuition instead of data-based rational analyses. The results of their study in California indicated that secondary principals mostly use their intuition for making decisions in the areas of program, policy, school safety, staffing and assignments. The results of this study demonstrate that high school principals in Nebraska more frequently used data for their decision-making in above areas. The following items with the very high mean scores very well illustrated this: (a) I use data to make recommendations regarding learning programs ($M = 4.20$, $SD = 0.73$), (b) to determine whether specific programs lead to improved achievement ($M = 4.16$, $SD = 0.70$), (c) to plan professional development programs

(M = 4.04, SD = 0.78), (d) to advocate for policies that promote success for all students (M = 4.10, SD = 0.87), (e) to identify safety issues (M = 3.83, SD = 0.92), and (f) to assign human resources in ways that promote student achievement (M = 3.93, SD = 0.82). The comparison of these two studies provides evidence that principals' use of data or intuition for decision making could be very complicated and situational.

School setting demographics and the importance of organization. The school setting factors in this study included two categories: (a) the school demography of school size and socioeconomic status, and (b) the school organizational operation factors of whether the school district required data-driven decision-making, whether the school had a team for data collection and analysis, and data accessibility for decision-making. These school setting factors were included in this study to determine whether they affected principals' use of data in their decision-making.

The findings of this study demonstrate that there were no statistically significant differences in principals' frequency of data-driven decision-making between the three groups of different school socioeconomic status and the three groups of different school sizes. There were no significant school demographic effects on principals' data use for their decision-making. According to Taylor (1991), it seems unlikely that the socioeconomic status has any appreciable effect on information behaviors, though it may influence individual access to information. However, Taylor suggested that empirical studies should be conducted for further investigation because there is no evidence on his proposition. This study met Taylor's suggestion of investigation and found that socioeconomic status of the school

organization did not significantly affect the principals' information behaviors of data-driven decision-making, which is in line with Taylor's proposition.

Although there were no statistically significant differences in data use for decision-making between the different groups of school size, it is noteworthy that the *p*-values of the ANOVA tests on both construct of School Instruction and School Vision were close to the alpha level of .01. The frequency of data-driven decision-making of principals working in small schools (with enrollment of 500 or less) was almost significantly lower than that of those working in large schools (with more than 1000 students). School size seems to matter at the data use on the two principal roles of instructional leader and visionary leader, in which principals practice more data-driven decision-making. Schools with large enrollment create more complex and ill-structured problems in school vision and instruction for principals than those with small schools. Moreover, the organization and personnel composition of large schools are much more complicated than small schools. These characteristics of school setting make principals of large school value and rely on data more frequently in decision-making.

School demographic effects on principal's data-driven decision-making appeared to be not as important as the factors of school organizational operation. School district requirement of data-driven decision-making was found to significantly impact the principals' use of data in decision-making in all of the four constructs of leadership areas. School team for data collection and analysis almost significantly affected principals' data-driven decision-making practices in both leadership dimensions of instruction ($p = .015$) and vision ($p = .021$). Data accessibility was

significantly related to principals' data-driven decision-making in all of the four constructs of leadership dimensions. It is the organization structure that the principals bring to the particular context that gives value to data, and makes if useful for decision-making (Knott & Wildavsky, 1980, as cited in Taylor, 1991). This study strongly confirms Taylor's proposition that work-setting features such as organizational hierarchy and the location of information sources significantly affect information behavior. The results are also closely consistent with the enriched literature review in Chapter 2.

Principals of the high schools whose districts that required data-driven decision-making used data for their decision-making significantly more frequently than those whose districts did not require data-driven decision-making. This result lends supports to the past research (e.g., AASA, 2002; Kirby & Bogotch, 1993; Reichardt, 2000). School district requirement represents one important aspect of exercising power, which determines preferences that are solidified through the operation of organizational control and incentive system. As authority implies legitimacy, legitimate power is often used by school districts in various aspects including principals' practices of data-driven decision-making.

Power has important ramifications for understanding the utilization of information. First, power is directly related to the ability to obtain scarce and critical resources, for example, budget allocation and staff assignment. Second, power is often used as the criteria in decision-making. The ability to define or specify evaluative criteria has direct impacts on subsequent decisions, and allows powerful actors to either specify the basis on which they are to be evaluated. Third, power is

often expressed as the established policies and procedures that the subunits use every effort to justify (Pfeffer, 1992; Pfeffer & Salancik, 1977). Organizational rules and regulations were identified as factors influencing information processing capability (Daft & Weick, 1984). In one word, power impacts the organizational contextual influences on use of information for decision-making (O'Reilly, 1983).

Principals of the high schools that have a team for data collection and analysis used data for their decision-making in both leadership areas of school instruction and school vision more frequently than those who did not established a team. A team approach for data collection and analysis can identify potential data sources, collect appropriate data, summarized, selectively interpreted and organized data and information, so that principals as the busy leaders do not need go through this time consuming process. A team approach can avoid or reduce conflicts and fears that may be caused by using data for decision-making.

However, it is a changing task for principals to organize a well-coordinated team to share the burden of information processing and to put it into the central functioning for principals' data-driven decision-making. Teamwork requires leaders' delicate organizational skills including eliminating the feelings of fears, creating trust and intimacy among the team members, and setting appropriate goals. Team members should be knowledgeable and well-trained in information management including coordinating, organizing, prioritizing, and limiting the information. Team members must also act as communication specialist. Therefore, a team approach doesn't mean simply finding several teachers and hoping them to work effectively. There is a big

effect difference in supporting data-driven decision-making between a team that works effectively and a team only composed of several teachers.

Since there are many evidences that a team approach for data collection and analysis contribute to principals' data-driven decision-making, the results of this study that there was no significant effect on the principals' data-driven decision-making may indicate that the teamwork reported by the principals did not work effectively and needs to improve. Team members of data collection and analysis in these schools might not very well understand the team's mission or their own roles and responsibilities. They might not know how to do their tasks or how to work as part of a team. They might not buy into the team's function, purpose, or goals, and even reject their roles or responsibilities.

In many studies, accessibility to information is a critical factor governing use of information for decision-making (e.g., O'Reilly, 1983; Taylor, 1991), which is supported by the results of this study in principals' perspective that the perceived data accessibility for decision-making is positively related to principals' frequency of data use for their decision-making. Data are more likely to be used by the principals as decision makers when they are readily accessible. When data are easily obtainable and retrievable, principals are able to gain access to them quickly when needed so that they can efficiently conduct data-driven decision-making. Principals as the subjects of decision-making are usually under time constraints and subject to numerous interruptions in their busy schedule. If the time and costs including psychological elements involved in obtaining data and information from less accessible sources, they may not make their every effort to use the data for their

decision-making. On the other hand, accessibility is also related to the appropriately processed and filtered data, which fits principals' need for decision-making. Accessibility is a function of sources proximity, physical effort required, as well as the psychological cost of using the data source (Choo, 1998; Taylor, 1991). Therefore, the key factor for principals' data-driven decision-making process is to have the right amount of data or information available at the right time.

Data quality perceptions. Principals' perceptions about data quality were found to be significantly positively related to their data-driven decision-making practices in the three constructs of (a) School Organizational Operation and Moral Perspective, (b) School Instruction, and (c) School Vision, but not significant in the construct of Collaborative Partnerships and Larger-Context Politics. However, there still existed a slightly positive relationship between data-driven decision-making and the perceptions of data quality in the construct of Collaborative Partnerships and Larger-Context Politics. Principals' perceptions about data quality generally significantly affected their use of data for decision-making in most of the leadership dimensions. The higher level a principal's perceptions of data quality, the more frequently he/she would use data for their decision-making.

The significant relationship between principals' perceptions of data quality and their data-driven decision-making practices means that principals who perceived data to be high quality (accuracy, objectivity, believability, completeness, and applicability) used data for decision-making frequently. This finding supports O'Reilly's (1983) research on examining whether the perceived quality of the source of information was the important factor in determining levels of use of information.

Among the most important elements influencing information use are the individual's attitudes towards information (Choo, 1998; Glickman, 1993; Jamentz, 2001; LaFee, 2002).

Data are more likely to be used by principals for decision-making when data are found to be accurate and understandable, appropriately collected, and correctly processed. Principals use data for decision-making when the data are objective, reflecting the true face of the programs and organization, with high reliability and validity and from a source seemed as trustworthy. Principals use data for decision-making frequently when they find the data were complete and clear with applicability and easily acted upon. Data that are used are supposed to be central to the principals' functioning such as assessing achievement of quantifiable goals of the school and are fed into a well-articulated and operating school system.

Difference of Factors Impacting Data Use on Different Leadership Dimensions

All the research questions in the former sections were discussed regardless of other contextual independent variables. It is best to investigate the impact of the important contextual independent variables integrated together on data-driven decision-making in the four constructs of leadership dimensions of Data-Driven Decision-Making in (a) Collaborative Partnerships and Larger-Context Politics, (b) School Organizational Operation and Moral Perspective, (c) School Instruction, and (d) School Vision. A growing body of studies suggested that context or information use environment might have some better predictors of needs and uses of information (e.g., Chatman, 1991; Savolainen, 1993).

The multiple regressions analyses indicate that school district requirement and accessibility of data were significantly influential in predicting principals' data-driven decision-making in Collaborative Partnerships and Larger-Context Politics. Since school district requirement has the higher structure coefficient than data accessibility, school district requirement of data-driven decision-making made greater contribution to the linear variate that predicted the principals' data use than principals' data accessibility. Principals whose school districts required data-driven decision-making and whose data accessibility was easier reported that they relied more on data in making decisions in their leadership dimensions of Collaborative Partnerships and Larger-Context Politics. Accessibility predicts use of information (O'Reilly, 1979)

The overall mean scores of principals' data use for decision-making in this leadership dimension of Collaborative Partnerships and Larger-Context Politics indicate that principals practiced data-driven decision-making the least frequently. Principals might either perceive data-driven decision-making in this leadership dimension not so useful or were still at the initial stage of using data for their decision-making. Therefore, it is understandable that if school district required it, they did it for the purpose of meeting the demands of policy and/or responded to the requirement as compliance of legitimate power. If data were easily accessible, they used them because it would not cost much time and efforts to obtain them.

Unlike the construct of Collaborative Partnerships and Larger-Context Politics, school district requirement and accessibility of data did not contribute significantly in predicting data-driven decision-making in instructional leadership. On

the contrary, principals' perceptions of data quality and data analysis skills were the two most influential variables in predicting principals' data use of decision-making in their leadership dimension of School Instruction. Data quality was more important than data analysis skills in predicting data use for decision-making in instructional leadership. Attitude towards data quality predicts use of information (O'Reilly, 1979). These results reveal that it was principals' perceptions of data quality and data analysis skills that significantly affected principals' data-driven decision-making in instructional leadership. If principals perceived data to be in high quality, and if they had good data analysis skills, they would use data more frequently for decision-making in instructional leadership. The frequency of principals' data use in instructional leadership did not have so much to do with school district requirement of data-driven decision-making, the school team of data analysis, and data accessibility.

Because principals practiced data-driven decision-making most frequently in instructional leadership, and they may have commonly recognized the important and benefits of data-driven decision-making, their data-driven decision-making may have been institutionalized, they did not need the organization hierarchical requirement to push them to use data for decision making. Their data-driven decision-making was not based on external mandates and compliance but relies instead on perceptions of data quality and the skills necessary for collecting and analyzing data. They didn't even worry too much about whether data accessibility was easy or not for them. Instructional leaders would be in most need of information because of their proactive

stance. They would need information automatically about the success of new programs and progress of toward goals (McColskey et al., 1985).

A school district requirement of data-driven decision-making was found to be only important contributor to the linear predictor variate in principals' data-driven decision-making in School Organizational Operation and Moral Perspective. This result demonstrates that of the five contextual factors, only school district requirement of data-driven decision-making could significantly make a significant difference in principals' data-driven decision-making in the leadership dimensions of School Organizational Operation and Moral Perspective. The other variables were not so influential and important.

A school district requirement of data-driven decision-making and principals' data-analysis skills were the two most influential variables that predicted principals' frequency of data-driven decision-making in school vision leadership. School district requirement was the more important contributor than principals' data analysis skills. If school district required data-driven decision-making and principals had a higher level of data analysis skills, principals were more likely to practice data-driven decision-making in school vision leadership. Principals' perceptions of data quality, accessibility of data, and school team of data collection and analysis did not make any significant difference in principals' data use in the leadership dimension of school vision. Figure 5 presents the influential factors of the contextual variables in predicting the four constructs of principals' data-driven decision-making.

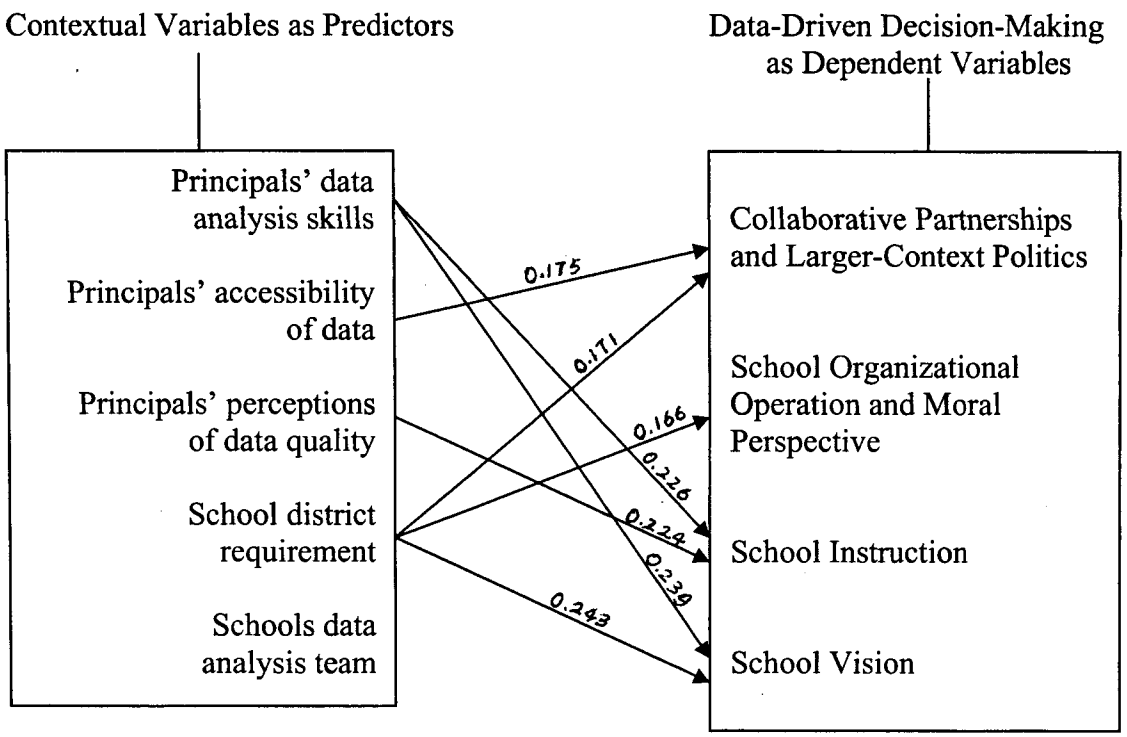

Figure 5. The different influential contextual variables in predicting principals' data-driven decision-making in different leadership dimensions

Note: the number above each arrow line is the beta coefficient for the relevant regression.

Conclusions from the Study Results

Based upon the purpose of this study, the results of the various survey data analyses provided a number of important and practical clues about data-driven decision-making as an emergent leadership strategy and its relationships with the contextual variables within the principals' work environment. First, it is encouraging and clear that data-driven decision-making was practiced frequently by the principals, especially in leadership dimensions of instruction and student learning, organizational operation, and school vision. Generally, a majority of the principals seemed to accept the values of data-driven decision-making and frequently used data to guide most of their decision-making after almost one decade of reinforcement in practice, policy,

and research under the movement of educational accountability. However, the frequency level of data use for decision-makings in the external leadership of school-community partnerships and larger-context politics was generally at moderate level. This not only to some degree reflects the shortcomings or negative side of principals' data-driven decision-making which are demonstrated by much research literature, but also provides the evidence that data-driven decision-making is still at its initial stage for principals.

In the human dimension of data-driven decision-making, there were no demographic effects on principals' data-driven decision-making, which supports Taylor's (1991) proposition that demography of the sets of people generally didn't significantly affect information behaviors. Principals' data analysis skills were found to be significantly related to the data-driven decision-making in the most of the leadership dimensions except the Collaborative Partnerships and Larger-Context Politics. In consistence with literature (O'Reilly, 1983; Taylor), there were differences in principals' use of data for addressing administrative problems as the decision-making process. Principals used data frequently in instructional leadership, organization operational leadership and school vision leadership, among which data use in instructional leadership was the most frequent. Principals' use of data was much lower in external leadership dimensions of school-community partnerships and larger-context politics.

Among the factors in the work setting, the school demographics of school size and school socioeconomic status did not significantly affect principals' data use. School district requirement and data accessibility had significant effects on

principals' data use while a school team of data collection and analysis did not contribute to significant differences in principals' data use. Principals' perceptions of data quality were significantly related to principals' data use for decision-making in various leadership dimensions. This study reveals that principals' data use for decision-making was situational (Choo, 1998, O'Reilly, 1983; Taylor, 1991). Generally, data analysis skills, attitudes towards data, the data demands of the leadership domain, the access to data, and the requirement of school district are dimensions of the school environment that could significantly influence data-driven decision-making.

Information behavior is a dynamic process, in which elements of the information environment interact actively with each other (Choo, 2002). Within the information environment, the high school principals' characteristics, the structure of the typical problem dimensions, the setting of school district and the school in which the principals work, and the modes of defining problem resolution all combine to establish a context for data use in decision-making.

In an integrated approach of statistical analysis, it was found that there was a difference in contextual factors that impacted data use on different leadership dimensions. A school district requirement of data-driven decision-making served as the significant predictor for three constructs of data-driven decision-making in (a) Collaborative Partnerships and Larger Context Politics, (b) School Organizational Operation and Moral Perspective, and (c) School Vision, but not in the important dimension of data-driven decision-making in instructional leadership. Principals' data analysis skills contributed significantly to predicting principals' data-driven decision-

making in the two leadership dimensions of school instruction and vision, in which principals practiced data-driven decision-making in high frequency. Principals' perceptions of data quality were significantly influential in predicting their data-driven decision-making in only, but a most important dimension, the leadership dimension of School Instruction in data use. Data accessibility significantly predicted data use for decision-making only in the leadership construct of Collaborative Partnerships and Larger-Context Politics. School data collection and analysis team did not significantly predict any of the four constructs of principals' data driven decision-making.

The integrated approach of data analyses seemed to imply that person-related or internal factors such as perceptions of data quality and data analysis skills tended to significantly contribute to principals' data use in the leadership areas, for instance, instructional programs and student learning in which data-driven decision-making was extensively practiced, well-accepted, reinforced in a lengthy manner, and for ill-structured problems. On the contrary, the organization-related or external factors such as school district requirement and data accessibility tended to be considerably influential in affecting principals' data use for decision-making in the leadership areas, for instance, school-community partnerships and larger-context politics, in which data-driven decision-making was less frequently practiced, vaguely controversial, at the initial stage, and for well-structured problems (see Figure 6).

As Simon (1997) suggested, individual's behaviors (such as decision-making and information use) in an organization were impacted by two aspects of influence:

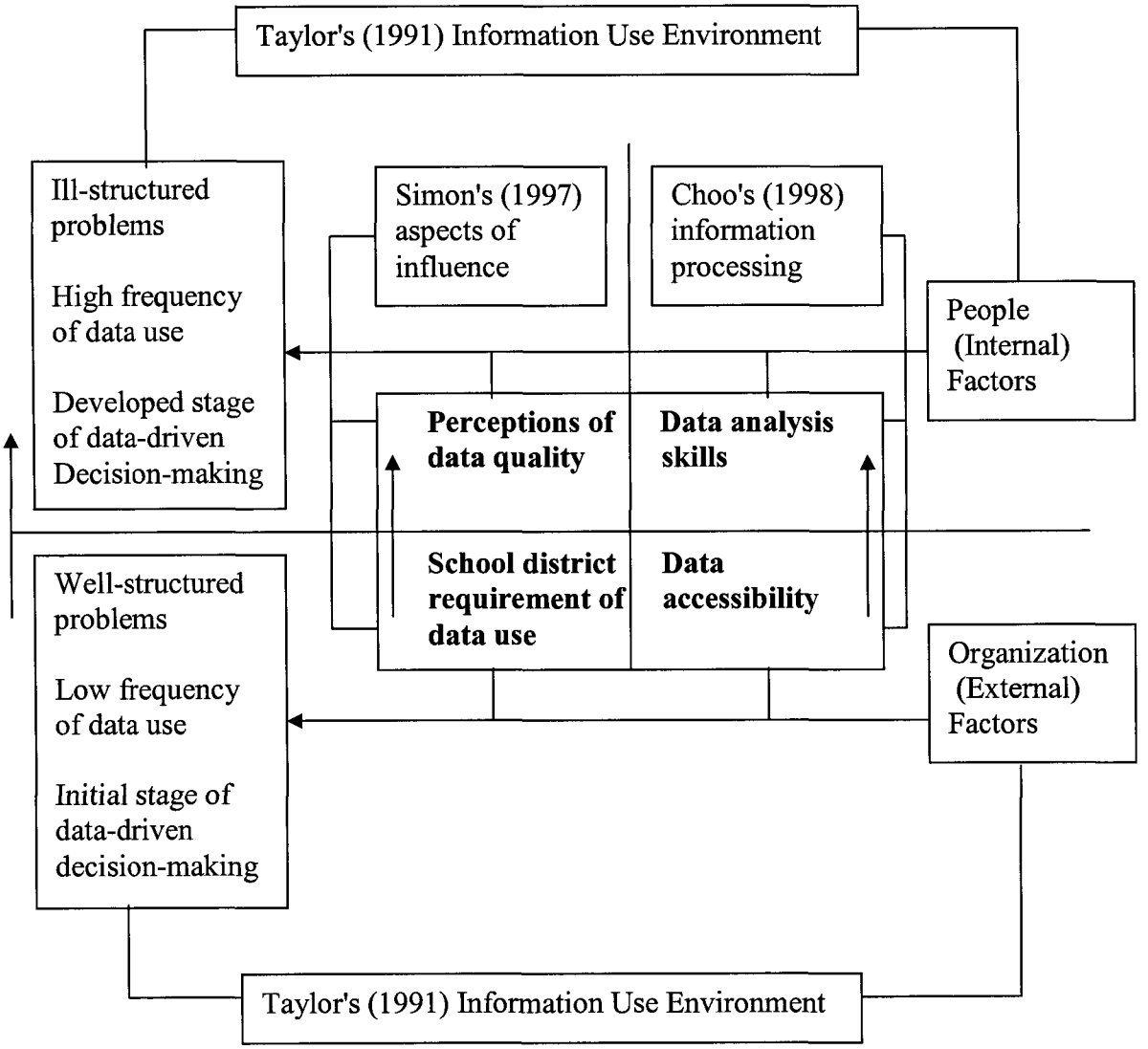

Figure 6. An integrated model of contextual variables significantly impacting principals' data-driven decision-making

the stimuli with which the organization seeks to influence the individual that is termed as "external" influence, and the psychological "set" of the individual term as "internal" influence, which determines his response to the stimuli. These two aspects of influence on individual's behaviors are distinguished (p. 177). Higher-order needs

are satisfied internally, whereas lower-order needs are predominantly satisfied externally (Maslow, 1954). In this study, the external influence of school district requirement of data-driven decision-making affected the lower-level frequency of data-driven decision-making while the internal influence of principals' attitude toward data affected the higher-level of data-driven decision-making. If these two factors are compared to each other based upon principals' recognition and acceptance level, it is not difficult to find that principals' attitude toward data quality is at the higher-order and school district requirement of data-driven decision-making is at the lower-order.

From the perspectives of information processing (Choo, 1998), data accessibility affected the lower frequency level of data-drive decision-making while data analysis skill affected the higher level of data-driven decision-making. Again, if these two factors are compared based upon principals' cognitive ability of information processing, data analysis skill is at the higher-order level and data accessibility is at the lower-order level. Therefore, the recognition level of data-driven decision-making and information processing level seemed to match or positively related to the frequency level of principals' data-driven decision-making.

Implications for Practice: Creating a Supportive Information Use Environment for Better Data-Driven Decision-Making

This study has provided findings related to the attention-attracting topic of data-driven decision-making and the contextual factors that affect principals' use of data for decision-making in the state of Nebraska, which connotes some important practical implications for promoting data-driven decision-making at schools. The following section presents an integrated model of practical strategies to create a

supportive information use environment for better data-driven decision-making with suggestions and insights framed around the research results and those found elsewhere in the empirical literature on the topics of information use environment and data-driven decision-making.

Balancing Data-Driven Decision-Making Practices in Leadership Dimensions

Data-driven decision-making contributes one of the most important aspects added to the revised ELCC/NCATE (2002) school leadership program. Every dimension of principal leadership is proposed to strengthen data-driven decision-making. Following are some examples: (a) Candidates use data-based research strategies to create a vision; (b) Candidates demonstrate the ability to optimize the learning environment for all students by applying appropriate models and principles of organizational development and management, including research and data-driven decision-making with attention to indicators of equity, effectiveness, and efficiency; and (c) Candidates apply an understanding of community relationships models, marketing strategies and processes, data-driven decision-making, and communications theory to create frameworks for school, business, community, government, higher education partnerships. However, data-driven decision-making is often confined to and only focused on the leadership dimension of instruction and student achievement. This is also supported by the results of this study that principals' use of data for decision-making was mostly frequent in instructional leadership while the least frequent in the leadership dimension of school-community collaborative partnerships. Based upon this finding, more efforts should be made to strengthen and promote data-driven decision-making in leadership dimensions of school-community

collaborative partnerships, school vision and school organizational operation. School district requirement of data-driven decision-making and creating data availability would be more effective strategies in promoting data-driven decision-making in these leadership dimensions, especially in school-community collaborative partnership.

Strengthening Principals' Data Analysis Skills

Data-driven decision-making requires new knowledge and skills. There is no lack of information for principals' decision-making in the school. The skills needed to search, select, evaluate, and use information can vary from total lack information skills to some level of literacy. How the principals solve this discrepancy will depend on their ability to embrace a basic competency, what is called information literacy, which is a significant contribution to data-driven decision-making practices. Information literacy is a set of data and information skills that enable principals to recognize how to locate, collect, analyze, evaluate, integrate, and communicate information. These skills are critical in dealing with the daily information and in using the broad array of tools to search, and organize information, and to analyze results and to communicate and integrate the results for decision-making (Bennet, 2004).

The results of this study that data analysis skills were related to use of data for decision-making and predicted use of data in instructional leadership suggest that this kind of training may be important. McIntire (2002) suggested that school administrators need to have two areas of skills to become good decision makers. One area is the fundamental spreadsheet and database techniques such as filtering, sorting,

and creating pivot tables and histograms. The other area is the fundamental data analysis concepts such as correlation and causation.

The superintendent and school board members should know how to provide effective data analysis training to principals. AASA (2002) suggested an implementation model emphasizing the following three points in training data analysis skills: (a) employees at all levels need to learn about data-driven decision-making; (b) districts cultivate in-house trainers who can help colleagues use the local data system; and (c) actual district data should be used in training only when appropriate. On the other hand, educational leadership programs need to recognize the unique leadership issues related to data-driven decision-making and to prepare administrators to deal with data collection and analysis in a practical way. Research and statistical courses in education leadership programs should shift their focus on training research skills related to thesis or dissertation writing to the practical data analysis and research skills related to school leaders' real world.

Using District Policy Requirement Appropriately

The use of information is a function of a decision maker's outcome preferences, which are solidified through the operation of organizational control and incentive systems. School districts' exercising of their sources of power is one of the crucial ingredients in the context of principals' data-driven decision making by defining, specifying, and emphasizing the criteria on which principals build their policies. This study reveals that school district requirement of using data for decision-making plays a key role in ensuring principals' data-driven decision-making practices. The impact of a policy requirement from a school district on data-driven decision-

making is even more pronounced in relatively new areas or early stages of data-driven decision-making.

This study strongly indicates that school district requirement of data-driven decision-making is significantly necessary and important in promoting principal's data use in the leadership dimensions of school-community collaborative partnership, school vision, and school organizational operation partnership. Principals use data less frequently and seem to be at early stage of data-driven decision-making in these areas of leadership. Data-driven decision-making, especially in the early stages, demands that district leaders point the way.

In addition to the policy-based requirement, school district support contributes other key elements to encouraging principals' practices of data-driven decision-making. In the study of understanding how exemplary districts use data by the Education Commission of the States (Armstrong & Anthes, 2001), results revealed that principals make decisions based more on relevant data as district leadership model data use at every opportunity, create meaningful assistance on data analysis, use sophisticated change-management strategies over time to engage principals in using data, and develop sophisticated instructional strategies. The central office plays a strong role in identifying promising practices and interventions. All districts that are good at data-driven decision-making also have specialists assigned as liaisons to individual schools and principals.

Creating Supportive and Effective Teamwork

A data-driven school requires a few knowledgeable staff members, supportive administrators, and institutionalized procedures for distributing data-collection

instruments, retrieving data, writing reports and informing decision-making (Noyce, et al., 2000). A team approach can make more and better information come from a group of people with various resources and skills. Also, there is a better chance that mistakes will be caught and corrected. Risk-taking is more likely because of the collective power of the group. Literature also suggested that teamwork of data collection and analysis has positive effects on data-driven decision-making (e.g., AASA, 2002; Bernhardt, 1998; O'Reilly, 1983). However, this study shows that there were not significantly differences in data-driven decision-making practices between principals who had a team responsible for collecting and analyzing data and those who did not. This may indicate that the most of the school teams of data collection and analysis did not work effectively. Therefore, school teamwork on data collection and analysis should be restructured and improved.

According to Cunningham and Gresso (1993), two factors are essential to a quality team: bonding and cohesiveness. Bonding ensures that team members will commit their time, knowledge, skills, and energy to the team and its goals. Members can begin this bonding process during the very first meeting, as they evaluate their purpose, goals, roles, and individual and group responsibilities. Cohesiveness is a sense of togetherness, or community, within a group. A cohesive group is one in which there are incentives for remaining in the group and a feeling of belongingness and relatedness among the members. An effective team needs to have the following qualities: purposefulness, pride, confidence, enthusiasm, empowerment, commitment, loyalty, and satisfaction. Data-driven decision-making teams are most likely to be successful when members are assessment and data analysis literate, have time and

interest to take the responsibilities, understand the team's mission, their roles, and the group process, establish a strong relationship of trust, and practice good communication skills.

Adopting Different Strategies for Different Administrative Dimensions

Strategies for promoting data-driven decision-making should be used in an integrated approach based on the notion that information behaviors are situational and the factors of the information use environments interact with each other. This notion is strongly supported by the findings of this study. For improving data-driven decision-making in instructional leadership that has been practiced frequently and in a developed stage, school districts or policy makers should focus on their time, efforts, and financial supports on enhancing the internal or "higher-level" factors such as principals' data analysis and upgrade their attitudes towards data quality. For improving data-driven decision-making in the leadership areas such as school-community partnership and school vision that have not been practiced so frequently or at the initial stage, the external or "lower-level" factors such as school district requirement and data accessibility should be strongly emphasized.

Information use is also dynamic (Choo, 1998). With effective change, a lower-frequency level of data-driven decision-making can be transformed into higher frequency level of data-driven decision-making. Similarly, the external factor of school district requirement of data-driven decision-making can be internalized into a principal's good attitude towards data-driven decision-making. A principal's passive approach of information seeking relying upon available data can be changed to an active approach of information processing by doing data analysis themselves for their

decision-making. In order to achieve these goals, it is critical to create a data-driven culture that supports collaboration, encourages the use of valued added information, and develops the spirits of positive change.

Nurturing a Data-Driven Culture

The cultural factors within the school district and school can also be critically important to the enhancement of principals' data-driven decision-making. Culture is the combination of shared norms, expectations, and unwritten rules that affects the information behaviors of principals. It is a set of underlying beliefs that affect principals' attitudes towards data quality. It also colors the perceptions of data-driven decision-making and affects the effectiveness of teamwork. In a data-driven culture, there is an institutionalized willingness to use data system to reveal important patterns and answer focused questions about policy, methods, and outcomes (Noyce et al., 2000). The notion of an institutionalized willingness is supported by the finding of the study that the internal factor principals' perceptions of data quality affected the higher frequency level of their data-driven decision-making in instructional leadership. The most important element of an effective data-driven program is not the data, the analytic tools, or even the curriculum frame on which data analysis is based; rather it is the school culture in which the data inquiry takes place (Salpeter, 2004).

The core value of a data-driven culture is sharing data, information, and knowledge for the purpose of school improvement. However, a nonsharing culture of information seems to exist in many schools or school districts because the collection and sharing of data, especially student achievement data, often creates negative consequences such as reactions with fear, distrust, resistance, perception of

unnecessary burden, and distrust with data. These negative consequences should be addressed first. School districts should take the responsibility of breaking down some of the existing barriers to information sharing, and give principals the tools and create the environment they need to share data, information, and knowledge. Successful data-driven decision-making requires a shift in the culture of a school district that encourages the use and analysis of data without fear of reprisal (AASA, 2002).

In order to get principals to buy into data-driven decision-making, superintendent leadership has to be able to see where it's going and have the courage to stay with it until it actually works in all schools (AASA, 2002). The superintendent has to be willing to pay the political price. "The culture of a school district will not smile favorably on data-driven decision-making for long if the members of that culture continually step on each others' toes or fumble the ball when it's their turn to run with the data. That is why the superintendent must draw the game plan in clear, bold strokes-to help principals understand their important roles in the data system" (p. 42). At the school district level, there must be a culture of support, trust and continuous improvement around data use.

Implications for Theory

This study, in addition to providing practical insights to data-driven decision-making, has implications for the body of theory in information and decision-making. Some of these are discussed below.

The initial impetus for this study came form the model of IUE (Taylor, 1991), which described the contextual factors that impacts information behaviors. The IUE consists of sets of people who share assumptions about the nature of their work and

the role of information in it. The work of these sets of people is concerned with problems characterized by dimensions that are applied to judge the usefulness of information. Their work settings influence their attitude towards information as well as the availability and the value of information. Their perceptions about problem resolution regulate the intensity of information search and their expectations about the kinds of information they need (Choo, 1998, Taylor). Taylor suggested that the IUE "can become a generalized model, a fruitful means for organizing, describing, and predicting the information behavior of any given population in a variety of contexts" (p. 251). The results of this study generally support the core proposition of IUE that information behavior is situational and multi-dimensional. This study also suggests that the IUE model provides a useful structure with which to describe the relationships between the contextual factors and the information behavior of principals' data-driven decision-making practices.

The important findings of this study that can contribute to the expansion and development of the IUE model fall into the problem dimension. Different problem dimensions not only shape the frequency of data or information use for decision making as suggested by Taylor (1991), this study also suggests that within the IUE's factors of set of people, problem, and setting, data or information use for decision-making in different problem dimensions were impacted by different factors of set of people and setting. For instance, a school district requirement and accessibility of data were significantly influential in predicting principals' data-driven decision-making in Collaborative Partnerships and Larger-Context Politics while principals' perceptions of data quality and data analysis skills were the two most influential variables in

predicting principals' data use of decision-making in the leadership dimension of School Instruction.

Finally, this study seems to suggest that the factor level (such as lower-order and higher-order) of both people and work setting match or positively related to the frequency level of information use for decision-making. For example, data accessibility as the lower-order of information processing significantly predicted the lower-order to data-driven decision-making in the leadership dimension of Collaborative Partnerships and Larger-Context Politics while data analysis skill as the higher-order of information processing significantly predicted the higher-order data-driven decision-making in the leadership dimension of school instruction. Although it may be inappropriate to regard this as a rule, this finding provides useful implications for further exploration about the contextual factors and their relationships to information behaviors.

Suggestions for Further Research

It may be claimed that this study was sound in meeting its purposes. However, this study had its limitations and delimitations. Based upon the limits and the findings and this study, the following suggestions are made for further study. First, broadened study subjects are recommended. As the subjects of this study were the high school principals in Nebraska, replications of this study are recommended with larger samples from different states and even in other countries. The design of this study can also be applied to elementary and middle school principals, and other types of school principals such as private school systems. From the personnel perspective, as data-driven decision-making is increasingly embraced by various

groups of school administrators and teachers, similar studies are recommended for these different groups. There is a strong need for more studies of differing populations working in varying contexts, and how individuals in these populations describe how specific information is used and how its use or nonuse affects their concerns (Taylor, 1991).

Second, measurement of other contextual factors is suggested in studying their relationships with information behaviors. This study was limited to some of the important contextual variables of Taylor's (1991) IUE model, which has been supported to have relationships with data use by the available literature in data-driven decision-making. Further studies can investigate the effects of other IUE factors such as people's social network, people's attitude toward technology, school district and school, organization structure, school history, and decision process. We may also investigate the resolution of problems, for instance, information use for difference purposes of identifying problems, making sense of a situation, generating strategies and predicting outcomes. Future studies are also recommended to add the dimensions of cognitive needs and affective responses investigating data or information use for decision-making (Choo, 1998).

Third, as this study did not differentiate data in investigating principals' data use, future studies might look at what types of data are mostly used or preferred by principals in different dimensions of leadership, if there are any differences, how principals acquire and use data in the process of decision-making.

Fourth, more practical topics about data-driven decision-making should be encouraged based upon the findings of this study. Future studies may look at what

level of data use for decision-making is effective and well accepted by principals, whether data-based rationality contradicts with "gut-feeling" in decision-making, why school data collection and analysis team do not impact data-driven decision-making, and what are the situations of the school teamwork on data-driven decision-making organized by the principals. On the other hand, the relationship between data-driven decision-making and the effectiveness of the principals as individuals or schools as organizations was beyond the scope of the examination of this study, but a positive relationship was assumed, which is the premise of data-driven decision-making and represents the beliefs and values of most policy makers and educators under the movement of accountability. This is another important area that needs comprehensive empirical research to support the premise of data-driven decision-making. However, it would be difficult and challenging to assess the relationship between data-driven decision-making and organizational effectiveness because of problems with operationalizing the concept of effectiveness and measuring information use. The lens of experimental and quasi-experimental designs would be a practical choice.

Fifth, in relation to research methodology, a mixed-methods approach should be embraced for better understanding of the complex phenomenon of data-driven decision-making. Survey research in this study can only capture the general individual perceptions. But most studies in data-driven decision-making were performed through either case studies or with interview. Case studies generally involve cognitive modeling approaches or phenonmenological analyses of the decision maker's experience during the decision-making process. Such assessments are frequently compared with various normative models that represent ideal behaviors

and strategies, and do not have generalizations. There are significant practical and theoretical difficulties in measuring the use of information for decision-making (Mandell & Sauter, 1984). Therefore, it is particularly necessary to apply multiple ways of knowing and studying of data-driven decision-making. By combining quantitative and qualitative methods, mixed-methods research provides stronger inferences and opportunity for presenting a greater diversity of views for the purpose of achieving standardized, efficient and amendable information as well as the contextual, cultural, and natural information.

Finally, most of the research on data-driven decision-making was not very well theoretically endorsed. Data-driven decision-making seems to be a new topic in education, but in the business world, it has been commonly used for a long period of time. There have been many well-developed management models in both theory and practice that are closely related to data-driven decision-making. Among the influential are Total Quality Management (TQM), Knowledge Management (KM), Organization Learning (OL), and Six Sigma. Moreover, data-driven decision-making is actually a cutting-edge topic between information science and decision-making science, which are the two key areas in leadership research and practice. Research on data-driven decision-making will be more in-depth and insightful if they are conducted by using information and decision-making sciences as the foundations and appropriately integrating with the management models such as TQM, KM, and OL.

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Appendix A: IRB Approval

University of Nebraska Medical Center
NEBRASKA'S HEALTH SCIENCE CENTER

Institutional Review Board (IRB)
Office of Regulatory Affairs (ORA)

February 24, 2005

Mingchu Luo
819 South 70th Plaza, #26
Omaha, NE 68106

IRB#: 052-05-EX

TITLE OF PROTOCOL: An Empirical Study of High School Principals' Data-Driven Decision-Making Practices and Its Relationships to Contextual Variables

The IRB has reviewed your Exemption Form for *Exempt Educational, Behavioral, and Social Science Research* on the above-titled research project. According to the information provided, this project is exempt under 45 CFR 46:101b, category 2. You are therefore authorized to begin the research.

It is understood this project will be conducted in full accordance with all applicable sections of the IRB Guidelines. It is also understood that the IRB will be immediately notified of any proposed changes that may affect the exempt status of your research project.

Please be advised that the IRB has a maximum protocol **approval period of three years** from the original date of approval and release. If this study continues beyond the three year approval period, the project must be resubmitted in order to maintain an active approval status.

Sincerely,

Ernest Prentice, PhD/GDK

Ernest D. Prentice, Ph.D.
Co-Chair, IRB

EDP/gdk

Academic and Research Services Building 3000 / 987830 Nebraska Medical Center / Omaha, NE 68198-7830
402-559-6463 / FAX: 402-559-3300 / Email: irbora@unmc.edu / http://www.unmc.edu/irb

Appendix B: Survey Cover Letter to High School Principals

University of Nebraska Omaha

EDUCATIONAL ADMINISTRATION AND SUPERVISION

IRB # 052-05 EX

Please click here to go to the survey:
http://coedb.unomaha.edu/mluo/p3dmi.htm

Dear High School Principal:

I am a doctoral candidate at the University of Nebraska at Omaha conducting a dissertation study. I would like you to complete the Principal Data-Driven Decision-Making Index (P3DMI) which is a self-assessment instrument that measures the extent to which high school principals practice data-driven decision-making in each of the six leadership domains specified in the Educational Leadership Constituent Council (ELCC) (2002) standards for effective administrative practice.

The survey that is attached to this letter contains the Principal Data-Driven Decision-Making Index (P3DMI). Your candid responses to the survey will make my dissertation study possible and more effective. I will be analyzing the responses of principals as a group, not individually. Your participation is voluntary, and your responses will be completely **anonymous.** There will be no way to link you to your responses.

The survey should take about 15 to 20 minutes to complete. Please follow the instructions given on the survey.

In reading and rating the items of the P3DMI, please keep in mind that data are confined to (1) student test scores; (2) demographics including attendance and graduation rates; (3) teachers', students', administrators', and parents' perceptions of the learning environment; and (4) data of school programs and instructional strategies (Bernhardt, 2003).

Thank you for participating!

Please click here to go to the survey:
http://coedb.unomaha.edu/mluo/p3dmi.htm

Mingchu (Neal) Luo
Doctoral candidate
Department of Educational Administration and Supervision
University of Nebraska at Omaha
(402) 554-3897

APPROVED
VALID UNTIL 02-12-05

6001 Dodge Street, Omaha, NE 68182-0162
402.554.2721 FAX: 402.554.2722

Appendix C: Advisor's Support Letter for the Survey

University of Nebraska Omaha

EDUCATIONAL ADMINISTRATION AND SUPERVISION

Dear High School Principal:

Mingchu (Neal) Luo, one of my doctoral students, is completing a dissertation in which he is using a survey approach to examine principals' use of data in problem solving. He may have contacted you and you may have completed the survey. If so, thank you very much. If not, I would appreciate very much if you would be so kind as to click the link and complete the survey within two weeks.

The surveys are straight forward and should take only 10 to 15 minutes to complete. I know you are very busy, but the information obtained from this study will benefit current and future principals.

Please do not hesitate to respond to me if you have any questions. If, for some reason, the link is not working, would you please let me know and we will mail a copy to you.

Thank you so much for your cooperation and valuable time.

Leon Dappen, Ph. D.
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Appendix D: Survey Instrument: Principal Data-Driven Decision-Making Index

Please read each statement carefully. Circle one of the following five scales that best describes your frequency of use of data for each statement.

1= Rarely or never
2= Seldom
3= Sometimes
4= Often
5= Usually or always

I use data to:

1. develop a school vision of learning that promotes the success of all students.	1	2	3	4	5
2. make decisions in aligning resources with the school vision.	1	2	3	4	5
3. insure that staff members are treated fairly.	1	2	3	4	5
4. understand the larger context of the community which affects opportunities for students.	1	2	3	4	5
5. generate potential elements of a vision statement.	1	2	3	4	5
6. make recommendations regarding learning programs.	1	2	3	4	5
7. generate approaches to curriculum improvement.	1	2	3	4	5
8. assign human resources in ways that promote student achievement.	1	2	3	4	5
9. plan professional development programs.	1	2	3	4	5
10. generate alternatives for improving school-community relations.	1	2	3	4	5
11. evaluate my ethical behaviors.	1	2	3	4	5
12. advocate for policies that promote success for all students.	1	2	3	4	5
13. identify safety issues.	1	2	3	4	5
14. promote an environment for improved student achievement.	1	2	3	4	5

Please read each statement carefully. Circle one of the five scales for each statement that best describes your frequency of use of data.

1= Rarely or never
2= Seldom
3= Sometimes
4= Often
5= Usually or always

I use data to:

15. judge my performance in effective management.	1	2	3	4	5
16. gauge the effectiveness of collaborative relationships with the community.	1	2	3	4	5
17. assess learning equity for different populations.	1	2	3	4	5
18. mobilize community resources for the benefit of student learning.	1	2	3	4	5
19. evaluate the instructional efficiency of the school.	1	2	3	4	5
20. predict the outcome of new instructional programs.	1	2	3	4	5
21. develop alternatives for implementing the vision.	1	2	3	4	5
22. develop effective approaches for school-family partnership.	1	2	3	4	5
23. determine what strategies to use in achieving the goals of advocating for all students.	1	2	3	4	5
24. identify the complex causes of school community concerns.	1	2	3	4	5
25. define possible problems in vision implementation.	1	2	3	4	5
26. identify problems in student learning.	1	2	3	4	5
27. develop effective communication plans.	1	2	3	4	5
28. determine what type of community input should be gained.	1	2	3	4	5
29. negotiate with political decision makers for the improvement of students' educational opportunities.	1	2	3	4	5
30. monitor instructional practices of the school organization.	1	2	3	4	5

Please read each statement carefully. Circle one of the following five scales that best describes your frequency of use of data for each statement.

1= Rarely or never
2= Seldom
3= Sometimes
4= Often
5= Usually or Always

I use data to:

31. guide my decision-making in budget formulation focus on student learning.	1	2	3	4	5
32. determine whether specific programs lead to improved achievement.	1	2	3	4	5
33. measure the effectiveness of outreach to the community.	1	2	3	4	5
34. suggest appropriate tactics when dialoguing with representatives of diverse community groups.	1	2	3	4	5
35. determine which community advisory committees should be formed.	1	2	3	4	5
36. generate approaches of my contacts with school stakeholders that reflect their concern.	1	2	3	4	5

Appendix E: Survey Instrument: Data Quality Scale

Please indicate your level of agreement with each of the following statements using the response scale listed below.

1= Strongly disagree
2= Disagree
3= Neutral
4= Agree
5= Strongly agree

1) Data are believable.	1	2	3	4	5
2) Data are objective.	1	2	3	4	5
3) Data are reliable.	1	2	3	4	5
4) Data are accurate.	1	2	3	4	5
5) Data are applicable to my work.	1	2	3	4	5
6) Data come from good sources.	1	2	3	4	5

Appendix F: Survey Instrument: Data Accessibility Scale

Please indicate your level of agreement with each of the following statements using the response scale listed below.

1= Strongly disagree
2= Disagree
3= Neutral
4= Agree
5= Strongly agree

1) Data are easily obtainable.	1	2	3	4	5
2) Data are easily retrievable.	1	2	3	4	5
3) Data are quickly accessible when needed.	1	2	3	4	5

Appendix G: Survey Instrument: Data Analysis Skills Scale

Please rate your comfort level for the following tasks using the response scale listed below in the next page:

1= Very uncomfortable
2= Uncomfortable
3= Somewhat comfortable
4= Comfortable
5= Very comfortable

1) Search information from databases	1	2	3	4	5
2) Design and create spreadsheets	1	2	3	4	5
3) Do some basic statistical data analyses	1	2	3	4	5

Appendix H: Survey Instrument: Demographics

Demographic Information:

1. Your age: _____

2. Your gender: 1. Male 2. Female

3. Your Ethnicity:

    1. Caucasian
    2. African American
    3. Asian/Asian American
    4. Hispanic
    5. Native American
    6. Other

4. Your highest educational level:

    1. Ph. D or Ed. D
    2. Ed. S (educational specialist)
    3. Master's degree
    4. Bachelor's degree

5. Estimate the number of the student enrollment in your school:_____

6. Estimate percentage of students receiving reduced and free lunch at your school: _____

7. Your total years being a principal at the present school: _____

8. Your total years being a school administrator: _____