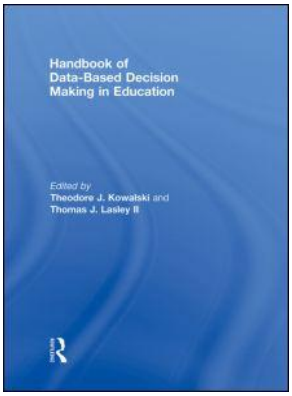


# Handbook of Data-Based Decision Making in Education

Theodore J. Kowalski, Thomas J. Lasley

## Developing and Nurturing Resources for Effective Data-Driven Decision Making

Publication details
https://www.routledgehandbooks.com/doi/10.4324/9780203888803.ch8
Anthony G. Picciano
**Published online on: 13 Oct 2008**

# Handbook of Data-Based Decision Making in Education

*Edited by*
**Theodore J. Kowalski** and
**Thomas J. Lasley II**

First published 2009
by Routledge
270 Madison Ave, New York, NY 10016

Simultaneously published in the UK
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

This edition published in the Taylor & Francis e-Library, 2008.



*Routledge is an imprint of the Taylor & Francis Group, an informa business*



*Library of Congress Cataloging-in-Publication Data*
Handbook of data-based decision making in education / Theodore J. Kowalski & Thomas J. Lasley II, editors.
p. cm.
Includes bibliographic references and index.
1. School management and organization–Decision making–Handbooks, manuals, etc. I. Kowalski, Theodor 1943– II. Lasley II, Thomas J. 1947–
LB2805 .H2862 2008
371.2 22

ISBN 0-203-88880-4 Master e-book ISBN

ISBN10: 0–415–96503–9 (hbk)
ISBN10: 0–415–96504–7 (pbk)
ISBN10: 0–203–88880–4 (ebk)

ISBN13: 978–0–415–96503–3 (hbk)
ISBN13: 978–0–415–96504–0 (pbk)
ISBN13: 978–0–203–88880–3 (ebk)

# 8

# Developing and Nurturing Resources for Effective Data-Driven Decision Making

*Anthony G. Picciano*
Hunter College

> A vibrant professional culture depends on a group of practitioners who have the freedom to continuously reinvent themselves via their research and knowledge production.
> (Kincheloe, 2003, p. 19)

## Introduction

During the past 50 years, humankind has experienced what many have called the computer or the information age, an era marked by the use of digital technology to collect, sort, manipulate, and report data. James Duderstadt, President *Emeritus* and University Professor of Science and Engineering at the University of Michigan, observed that educated people and their ideas, facilitated and augmented by information technology, have become key to our social well-being and a driving force for great change in all social institutions (Duderstadt, 1997). Corporations, government agencies, and schools have devoted significant resources to the computer-information age through the development, expansion, and improvement of their computer-based information systems.

For the past decade, the computer-information age has been evolving into the age of knowledge. Drucker, world-renowned writer and consultant, has called knowledge, rather than capital or labor, the only meaningful economic resource of the post-capitalist society. He believes one of the most important roles of management is to ensure the application of knowledge, and the application of knowledge to knowledge (Drucker, 1993). Success and progress will depend upon the ability of institutional leaders to harness information about what is happening within an organization and convert it into knowledge while monitoring the forces that influence the organization from the outside. In this chapter, the development and nurturing of information resources is examined as the foundation for establishing effective data-driven decision making in a school or school district. Specifically, the hardware, software and, most importantly, the people components of data-driven decision making are examined as the foundational components of every successful information system development and implementation.

## Information Infrastructure

*Webster's Third New International Dictionary* defines infrastructure as the underlying foundation or basic framework of an organization or system. The term can be applied to a host of entities, such as energy, water, or communications, that undergird an organization—state, city, corporation, medical center, or school district—and its operations. Conceptually an organization's infrastructure might include a central source such as an energy power station, water supply, communications center or school district information system that distributes resources through a series of nodes. The flow (see Figure 8.1) is frequently top-down from the source (e.g., school district office) to the nodes (e.g., individual schools and administrative departments). In the case of information systems and the distribution of data throughout an organization, the emergence of digital communications and the Internet/World Wide Web has changed the conceptual framework of the infrastructure. While central sources for communications and data processing activities still exist, a more appropriate diagram (see Figure 8.2) of an organization's information infrastructure shows a hub-based network in which resources are shared across all nodes rather than moving back and forth or from the top-down between the central source and the nodes within the organization. Fundamental to this model is the ability of nodes to share resources with other nodes without necessarily going back to the source. This model is particularly important when developing the information infrastructure for data-driven decision making in a school district. All those involved in decision making are able to share activities, strategies, and data with one another. While technical assistance, support, and databases may be provided centrally at the district level, ultimately the success of the data-driven decision-making process will rest on the ability of individuals in the schools to effect changes in classrooms and offices. It

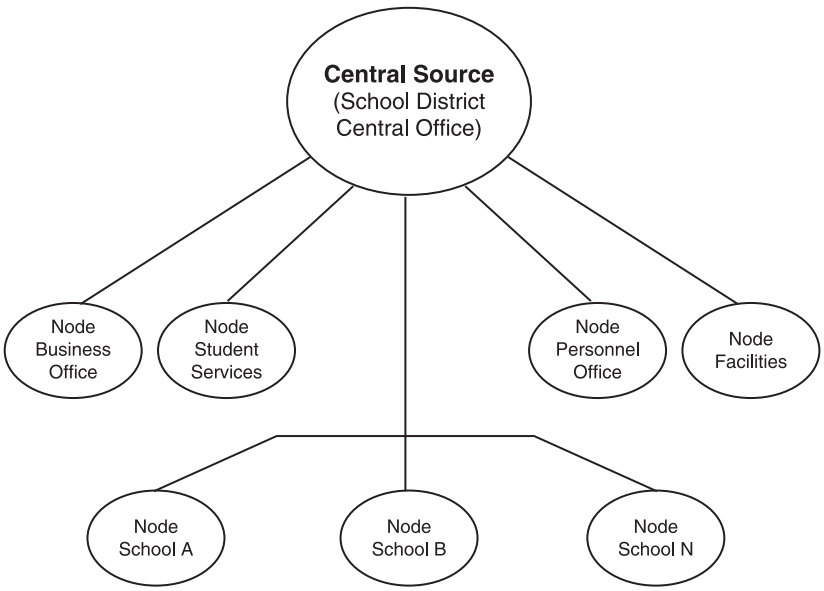


**Figure 8.1** Central source (top-down) information infrastructure.

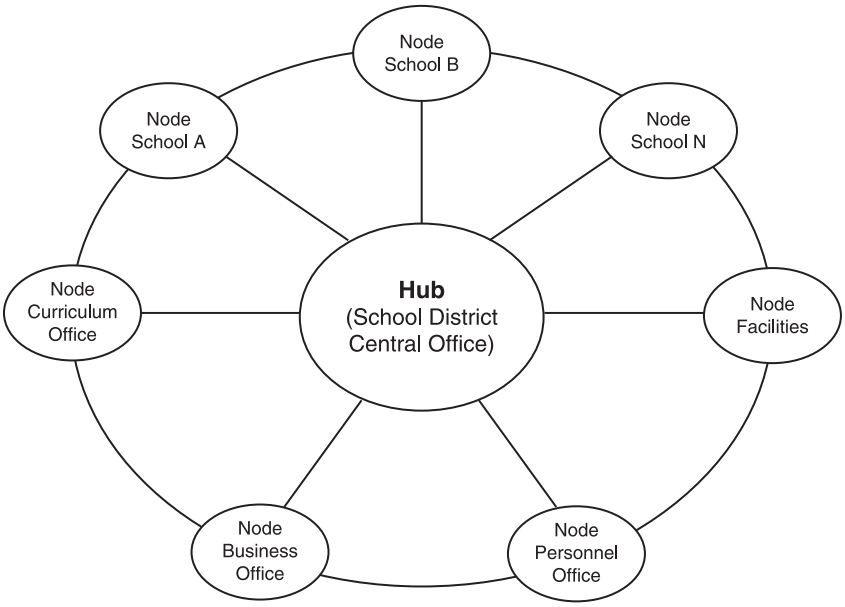


**Figure 8.2** Hub-based information infrastructure.

is highly desirable, if not critical, for administrators and teachers in the schools to share their knowledge, expertise, and experiences with others across the district. This framework for sharing information resources across the school district is the foundation that will empower shareholders and enable them to realize the potential of data-driven decision-making activities in their schools. When conceptualizing infrastructure, the tendency is to think about the physical elements of the system. This is not the case with data-driven decision making where it is most beneficial to think of the infrastructure as composed of hardware, software and especially people—their expertise, experience, and knowledge.

## Hardware for Effective Data Management and Access—Networks

During the past several decades, educators have seen data communications systems and networks develop in size, sophistication, and the ability to communicate over distances. In the late 1970s and 1980s, schools began to install their first local area networks, or LANs. By the mid-1990s, the vast majority of the 15,000-plus school districts in the country had established one or more LANs (Quality Education Data, 1995). The use of LANs in computer laboratories, libraries, and administrative offices has now become commonplace. In larger school districts, wide area networks (WANs) are also in evidence connecting computers and LANs that are dispersed throughout the district sometimes miles apart. In a WAN configuration, a large computer network serves to integrate the activities of smaller computer networks. Using a district-wide WAN, a student in one school, for example, can determine whether a library in another school has a particular book, an assistant principal can examine the transcript of a student who has just transferred from

another school, or a district business manager can monitor the daily expenditures of several schools.

The data communications technology (e.g., cables, telephone lines, satellite transmission) that enables a computer in one school to communicate with a computer in another school is essentially the same whether the schools are many miles apart or in close proximity. Once a WAN has been established, the distance between sites becomes immaterial. In the late 1980s, this concept flourished as computers in school districts began to communicate with computers on networks outside the school district. A student looking for a particular book might use a computer in a school's library to locate the book at a local public library or a local college library. A superintendent using a computer in a school district office might transfer data on student demographics to a computer located in a state education office.

In the 1990s, data communications technologies continued to advance to the point where a computer on one network could easily communicate with a computer on another network thousands of miles away. Now, the grants officer in a local school district office in Juneau, Alaska, can examine a database of funded programs on a computer network maintained by the United States Department of Education in Washington, DC. A state education department administrator in Albany, New York, can e-mail a new curriculum proposal to all 800 school district superintendents on a state-wide education network. A social studies teacher in Tulsa, Oklahoma, developing a module in cultural studies, can access a database of curricular materials maintained by the National Geographic Society.

With the expansion of data communications' capabilities over the past two decades, networks have expanded to cover greater distances and to link with many more networks. Increasingly, this data traffic, occurring on thousands of networks throughout the country and the world, is passing over a common universal network we call the Internet. As of 2003, 97% of all schools in the United States were connected to the Internet (Park & Staresina, 2004). To support data-driven decision making, the school district's fundamental hardware configuration comprises computer workstations distributed on a high-speed digital network which is fully compatible with the Internet. Each node in the school district's network may be a school or office with its own mini-network capable of intercommunication with any other node in the district as well as with networks outside of the district.

Once a network is in place, the next question is "where should the computer workstations be located?" The answer to this question is everywhere. The Internet was established as a ubiquitous resource; users are able to connect to it from anyplace. Administrators have computer workstations in their offices, teachers in their classrooms, parents and students in their homes. As early as 1989, the NEA recommended that a computer be installed on the desk of every teacher (National Education Association, 1989). The emergence of portable electronic devices, namely laptop computers and personal data assistants (PDAs), allows connectivity to the network from anyplace there is a telephone connection or a clear satellite signal. While all school districts have not yet provided computers to all of their teachers and staff, this is the direction in which Internet-based technology is heading. The long-range plan for developing data-driven decision making calls for providing access to information resources to just about everybody in a school district. Principals, teachers, and

administrative staff should have ready access to information about students, budgets, and personnel. Furthermore, these resources need to be available so as to allow access from anyplace (office, classroom, home) that a desktop, laptop, or other portable electronic device can connect to the Internet.

The implementation of an extensive data communications system to support the development of information resources needed for data-driven decision making may appear daunting; however, the vast majority of school districts have already begun to make this investment. It is critical that the leaders in these districts nurture and maintain these systems to keep up with current communications technologies. If we consider other enterprises where access to information is important, we can easily understand the need for this ongoing investment in our schools. When we go to a bank, we expect to see tellers accessing information about our accounts via computer workstations. We make deposits and expect ready access to our funds at ATM machines located anywhere, including shopping malls and supermarkets. In today's world, what would we think if the teller at our local bank accepted our funds and wrote the transaction in a notebook? Our children are more important than our bank accounts; the most efficient methods must also be employed for making decisions about their "educational transactions."

A final comment about the power of networks. Networks are not just simply the latest technological advancement designed to move data more efficiently throughout an organization. They can have profound effects on how people work with one another. Watts (2003) and Birabasi (2002) have studied the effects of networks on various people-intensive processes. What they have found is that networks enable individual behavior to aggregate into collective behavior. Something special happens when individual entities (nodes, components, people) are able to interact to form larger wholes (networks, systems, communities). Furthermore, the "interaction effect" or collective behavior may result in a far more productive environment than individuals acting by themselves: one individual working with another individual does not simply comprise two individuals but a third, more powerful collaborating entity which can extend the benefits beyond two. Modern data communications networks now make it possible for many individuals to share and work with one another, and their collective behavior can be most effective in supporting complex processes including data-driven decision making.

## Software for Data Management and Analysis

### *The Database Management System*

Database management is the underlying software system for developing and supporting a school district's information resources. The terminology used for describing databases has been inconsistent over the years, and certain terms mean different things to different people. Identifying and defining some of these terms may be helpful. The general definition of a database is a collection of files in which data can be created, updated, and accessed. However, a more modern definition of a database requires that the data files be interrelated or integrated so that data can be accessed

easily across all files and redundancy of the data be kept to a minimum. The basic concept of databases involves managing the data in an increasingly more complex hierarchy. The members of this hierarchy, from least to most complex, are the *character*, the *data element*, the *data record*, the *data file*, and the *database*. When integrated, the members of this hierarchy form a school district's information system. The software that controls, integrates, and provides reports from this information system is the database management software system.

Figure 8.3 illustrates the major administrative database applications that comprise a school district's information system. Each application area has a unique role in contributing to the overall information resources of a school. The student applications tend to be the most complex because of the amount of data that needs to be collected. In addition, student data in these applications are volatile and subject to frequent change. Applications such as attendance reporting and scheduling require extensive data collection efforts and careful coordination. Student applications are important because certain areas such as achievement and performance come under a good deal of scrutiny, from both inside and outside the school. Administrators need ready access to information such as retention, attrition, graduation rates, and test scores. Student enrollment data are also usually critical for various state and local funding formulae, and accurate data on students in attendance become a necessity for various reporting purposes.

Curriculum and course applications are vital for a school's internal academic operations. Curriculum meetings and discussions are, in many schools, the centerpieces of academic planning. Administrators and teachers collect extensive amounts of data to develop new courses and modify existing ones. Data on student performance tied to curriculum and course enrollment become critical for such planning.

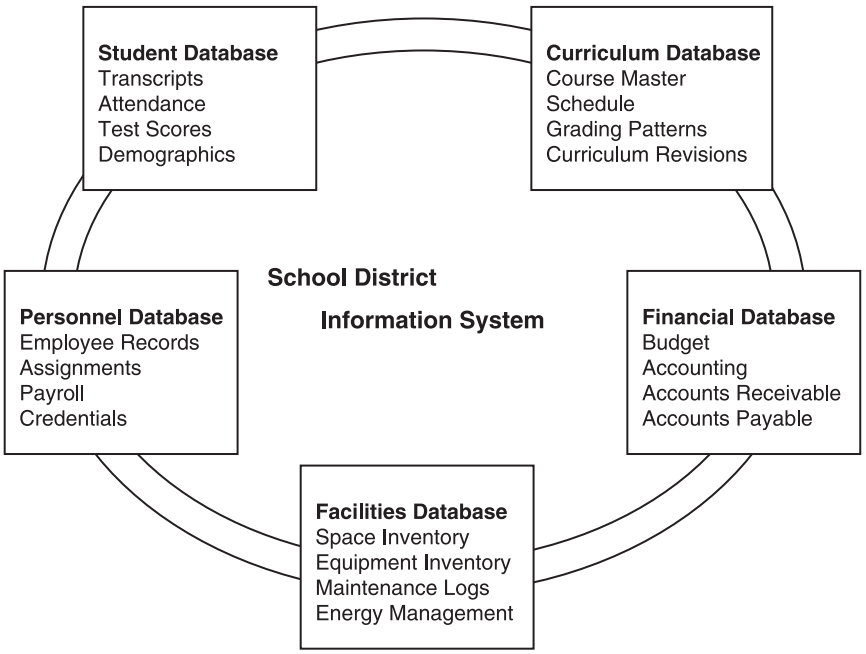


**Figure 8.3** School district information system.

A good curriculum and course database is also necessary for developing a student scheduling application, one of the most time-consuming activities when done manually or without sufficient technological support.

Personnel and financial applications are frequently the first database systems to be implemented. In public schools, they may tie into other local governmental agencies for applications such as payroll, accounting, and purchasing controlled at the municipal or county levels. For any administrator, the management of a budget is a critical responsibility. Access to up-to-date and accurate information on budgets and finances is a necessity and affects all of a school's operations. Personnel files are important complements to the financial data files for purposes of managing a budget, because the major costs in most school operations are personnel items such as salaries and fringe benefits.

Facilities are generally the last of the database applications to be implemented. Facilities data are not as critical or volatile and do not need to be as tightly integrated. However, applications such as space utilization, equipment inventory, and supplies inventory should not be ignored because they contribute to overall effectiveness and efficiency.

The database management system software is common to all of the applications in Figure 8.3 and serves as an integration mechanism. It also allows a school district to warehouse or maintain data longitudinally (over time). This becomes most critical in analyzing student progress from semester to semester and year to year. By developing such a system, schools greatly enhance administrative cohesiveness because offices become more dependent on one another by virtue of sharing common data files. A single system also significantly improves the consistency of information and eliminates issues involving the accuracy of one office's data versus another's.

### *Data Reporting and Analysis*

One of the most important features of database software is the ability to generate reports. A query language is generally provided that enables users to access data in many different ways. Query languages were the precursors to search engines that have been popularized on the Internet and World Wide Web. However, the power of query languages is that they can be customized to access data stored in a specific database system. For this reason, query languages are very efficient in providing specific information, creating reports and establishing temporary data files for subsequent analysis. Designed for non-technical staff, they can give users excellent access to data while eliminating dependence upon others to perform the task. Query languages also allow teachers and administrators to go beyond static standardized reports that have a set format and cannot be manipulated and altered. They can be used to create subsets of the database that can be analyzed and reanalyzed delving deeply into a particular issue regarding a particular group of records. For instance, a committee of mathematics teachers could create a subset of the test scores of all the students in fourth grade in order to analyze and reanalyze performance compared to student demographics and characteristics. If they need additional information, they simply

do another query on the data subset. This method of inquiry is far more sophisticated and effective than examining a static (either on paper or on a display screen) report. This analysis and reanalysis is referred to as data mining, a common term used in data-driven decision-making activities that refers to searching or "digging into" a data file for information in order to understand better a particular phenomenon.

One of the most commonly used tools for analyzing data is the electronic spreadsheet, including programs such Microsoft Excel and Quattro Pro. Used for applications that require frequent analysis and manipulation of numbers such as budget, accounting, enrollment projections, and test scores, electronic spreadsheet software is essentially an electronic grid or matrix of rows and columns. It replaces the accounting tablet as a tool for organizing numbers into appropriate boxes or cells, and it performs automatically the arithmetic operations that formerly were performed manually or with calculators. It also provides graphics capabilities for producing bar graphs, pie charts, and line graphs which are very effective in doing longitudinal and trend analyses. When integrated with query languages, spreadsheets become indispensable for financial analyses when preparing budgets, projecting expenditures, and determining personnel costs.

A complementary and a more powerful tool for data-driven decision making is the statistical software package such as the Statistical Package for the Social Sciences (SPSS) or the Statistical Analysis System (SAS). These packages can perform most of the data analysis routines that Excel and other spreadsheet programs do and in addition can much more easily perform statistical routines such as contingency tables (cross-tabulations), frequency distributions, and correlations. While spreadsheet software is a good starting point for doing basic data analysis, statistical packages such as SPSS can take the analysis much further. The latest version of SPSS has been converted to a spreadsheet-like format so that users familiar with software such as Excel can more easily learn SPSS.

A final comment on data analysis software tools is that they are critical in analyzing, manipulating, and presenting data and are most effective when integrated with database management systems. The benefits of these tools are best realized if they have good data sources such as a school district database from which the aggregate data are drawn and are shared among all stakeholders in data-driven decision-making activities. As mentioned previously, critical to the effectiveness of these tools is the concept of mining (analyzing and reanalyzing) a dataset rather than reading numbers from a static paper report.

## People, Decision Making and the Social Nature of Information

### *Building Communities*

A good deal of literature exists on the importance of collaboration in decision making. Authors such as Senge (1990; learning organizations) and Wenger (1999; communities of practice) see collaboration as crucial for organizations to grow and thrive. In a sense, organizations are transformed into organic entities that learn and advance;

advance and learn. Sergiovanni and Starratt (1998) redefined educational administration as reliant on "organic management" that makes the promotion of the community the "centerpiece" of supervision. Each of these authors has promoted concepts that elevate school management above the bureaucratic, top-down, do-it-this-way style of administration to another level of collaborative, we-are-in-this-together activity. In more recent years, a link has been made between collaboration and information sharing especially with regard to complex decision processes and the use of data as the fulcrum upon which communities develop. Seeley Brown and Duguid (2002), in their work entitled *The Social Life of Information*, call for a better understanding of the contribution that communities and people make to complex decision processes and a realization that the data, information systems, and technology only take the process so far. This concept is essentially an extension of the Nobel prize-winning work of Simon (1945, 1957, 1960, 1979, 1982), on the "limits of rationality" or "bounded rationality" which posited that rational decision-making processes are "limited" and people with their expertise, intuition, and experience are critical to effective decision making.

Increasingly, dialogue and social interaction in decision making are being seen as critical to effective management and administration. Elmore and others have expressed concern that teachers in particular have not been encouraged to engage in dialogue, nor are they often given the time or support to allow such activity (Elmore, 2004; Wilhelm, 2007). Wilhelm (2007, p. 19) begs the question: "Why are meaningful inquiry and exploratory dialogue so rare in American schools, despite the fact that leading researchers agree that it is essential to student learning?" While hardware and software are the vehicles for delivering accurate and timely information, there is still great concern that integrating these with the people element is lacking in many schools. Most of these people are school-based and include administrators who know their schools and constituents; teachers who know their students and curricula; and staff who know their operations and services. All of them need to be trained and brought together to use the information resources that will help them make informed decisions.

### *People Development*

A good training program first starts with the design of the technology resources (hardware, software, data) to be used by those involved with data-driven decision-making activities. While it is true that the development of extensive information resources using current technology is complex, the complexity of the design need not be passed on to the end-users. On the contrary, modern technology design emphasizes the importance of providing user-friendly interfaces to information resources. Information systems that require many levels of inquiry in order to download basic information, World Wide Web interfaces that are overly cluttered, or database software that lacks a friendly query language are systems that will be difficult for end-users.

Secondly, training workshops and classes must be readily available either in person or online. The nature of these sessions will depend upon the level of technological

expertise that exists within the staff. If technology and sophisticated information systems are new to a school district, then the staff training and development will be extensive. However, technology is constantly evolving so that even sophisticated technology users will need to refresh and update their knowledge and skills on a regular basis. Learning to use an information system and its resources for data-driven decision making will require specialized staff development activities not limited to the use of technology. Additional training in other areas such as curricula, standards, testing, and the fundamentals of quantitative analysis might also be necessary.

Thirdly, every good staff development training program is ongoing; one-time workshops are only modestly successful. If data-driven decision making is to be integrated into the administrative fabric of a school or district, then ongoing training will be needed to keep skills honed and to allow entry to the process by new teachers and staff. Furthermore, given that so much educational activity is influenced and guided by multiple levels of government, decision making must regularly adjust to the newest regulation, standard, or directive. Participants in decision-making activities will need to be kept up-to-date if they are to be effective.

Lastly, data-driven decision making requires enhanced leadership skills on the part of district supervisors, principals, and other administrative staff. School leaders must be capable of setting a climate that allows for a "we" process that includes teachers and staff rather than a "me" process. Teachers and staff will need to feel comfortable and that they are not the objects of data-driven exercises wherein their skills and abilities are constantly questioned. Given the current emphasis on accountability and standards, teachers have become a focus of attention in the success or failure of our children. Teachers and other staff are indeed critical to the educational enterprise; they should be treated, assigned, and developed with skill and competence. Price (2004) in an article entitled, "New age principals," that appeared in *Education Week*, expressed concern that:

> Both current principals, and those entering the principalship for the first time, find that they are ill-prepared to manage an infrastructure that supports instruction and has as its constant focus the technical core of teaching and learning.
>
> (p. 36)

He recommended that all principals, new and old, develop four key skills to create and manage the type of infrastructure needed to support instructional improvement:

1. ability to manage information
2. ability to analyze and use data to determine areas in need of improvement
3. ability to align and monitor curriculum to meet needs
4. ability to build a professional community of learners (stakeholders) committed to instructional improvement.

While all four of these skills are important, the last is the most critical and undergirds all the others.

### *The Data Analyst*

As school districts begin to invest in data-driven decision processes, the need for someone with technical expertise in data analysis becomes more apparent. The data analyst possesses a number of skills, especially familiarity with information systems and fundamental statistical analysis, and serves as an important resource person for others (administrators, teachers, parents) in using data effectively. The data analyst also performs a coordinating function by providing data in a timely manner so that they coincide with a district's or school's planning activities. Minimally, as data-driven decision-making activities evolve, districts will have one person performing this function on a full-time basis. Large districts will have more than one person, depending upon size. In addition, individual schools will have someone performing this function perhaps on a part-time basis, while large schools, especially middle and high schools, will likely have a full-time person.

The need for a data analyst has grown considerably as data are used more frequently in shaping instructional activities. In other areas where data are critical for decision making such as budget and finance, it is more likely that the staff assigned to these areas will have had some formal training in information systems management and business statistics or quantitative analysis. In addition, generally a small cadre of business personnel work with data files on a daily basis and are comfortable "mining" these files to support decision-making activities. Instructional decision making, however, requires sharing data on students, testing, and other performance indicators with teachers and parents who are going to be less familiar with data analysis. The data analyst can be very helpful in designing standard reports that are produced on a cyclical basis and that serve as common resources in the discussion and planning of instructional activities. In addition, with some training and assistance, teachers will use the standard report to begin the process of mining the data as group and individual judgments about instruction evolve. The support of a data analyst with expertise in information processing and quantitative methods will facilitate their analysis and judgments.

Another way in which a data analyst can be helpful is in monitoring the external environment. While much of data-driven decision making is internal to a district or school, scanning the external environment for resources or data-related mandates and compliance issues can be helpful if not critical. Front-line administrators have difficulty finding the time to do this effectively while a data analyst may be able to do this quite easily.

Finally, data-driven decision making for instruction also assumes that the community, especially parents, will be invited to become involved in the process or at least to share in its results. To involve the community, reports will have to be easily understood by the broader population. Having a knowledgeable data analyst design, explain, and answer questions about these reports will contribute to the success of the activity and garner support from the community.

## Evaluation and Nurturing the Process

The relationship between modern information systems and decision making has been evolving for many years. While the term "data-driven decision" has gained popularity in K-12 education during the past 10 or 15 years and especially since No Child Left Behind in 2001, it has been used and studied conceptually in other organizations for decades. Mason (1969) and later Craven (1975) studied "information decision systems" that established the importance of information to the decision process in private industry and public agencies. One important aspect of their approach (see Figure 8.4) is the evaluation of the decision-making process. Evaluation requires stakeholders (administrators, teachers, staff) to review how well the process worked and to reflect on the effectiveness of the decisions and courses of action taken. Unfortunately, the evaluation step is not always taken or is sometimes done very informally with little feedback into future decision-making activities. What Mason, Craven and others recommended is that evaluation be formalized as part of the decision process and that the outcomes of the evaluation be used as input or "lessons learned" into future decision processing. In this approach, evaluation is never punitive but is used positively and formatively to help improve and nurture the process for the next decision-making cycle. Issues typically examined in an evaluation involve stakeholder access to accurate and timely data, knowledge of stakeholders and their readiness to engage in decision making, and a clear delineation of the outcomes of the decision. However the evaluation is configured, stakeholders will do well to reflect on and determine what worked well in their decision making and to learn from those elements that did not work as well. It is in this manner that schools become less bureaucratic institutions and more organic communities that grow to the best they can for their students.

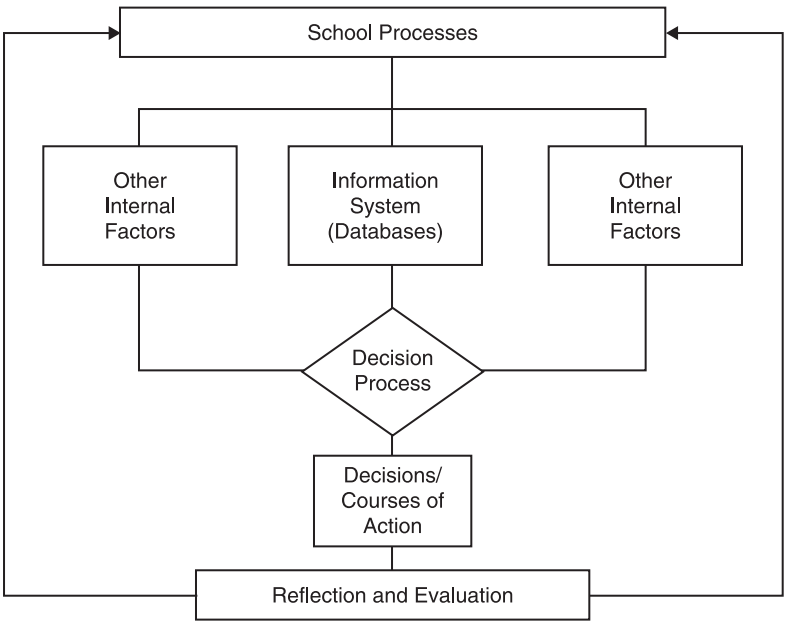


**Figure 8.4** The decision process model.

This last point ties back to the work of Senge, Wenger, and Sergiovanni and Starratt mentioned earlier in this chapter. Education leaders and policy makers interested in promulgating effective decision-making processes in their schools need to develop communities in which all stakeholders see themselves as moving forward toward a common goal. Data-driven decision-making processes can help in this movement forward. In addition to operational aspects such as current hardware technology, user-friendly software that provides accurate and timely data, and informed and knowledgeable people, data-driven decision making needs enlightened leadership to integrate these into a dynamic process that utilizes as well as fosters a sense of community. The enlightened leader sets in motion group decision processes that trumpet "we are in this together" rather than "you better be careful if this does not work out." Embracing evaluation as a positive and healthy activity that nurtures and helps grow the school community works best. In sum, data-driven decision making is a technology-based process that requires the human touch in order to reach its potential as an effective tool in moving the education of our children forward.

## References


Birabasi, A. L. (2002). *Linked: The new science of networks*. Cambridge, MA: Perseus Publishing.

Craven, E. C. (1975). Information decision systems in higher education: A conceptual approach. *Journal of Higher Education*, *46*(2), 125–139.

Drucker, P. F. (1993). *Post-capitalist society*. New York: HarperCollins.

Duderstadt, J. J. (1997). The future of the university in an age of knowledge. *Journal of Asynchronous Learning Networks*, *1*(1), 78–88. Retrieved September 23, 2007, from http://www.aln.org/publications/jaln/v1n2/v1n2_duderstadt.asp

Elmore, R. (2004). *School reform: From the inside out*. Cambridge, MA: Harvard Education Press.

Kincheloe, J. (2003). *Teachers as researchers: Qualitative inquiry as a path to empowerment* (2nd ed.). London: Routledge-Falmer.

Mason, R. O. (1969). *Basic concepts for designing management information systems* (AIR Research Paper No. 8).

National Education Association (1989, July). *Report of the NEA special committee on educational technology*. Paper presented at the 127th annual meeting of the National Education Association, Washington, DC.

Park, J., & Staresina, L. (2004, May 6). Tracking U.S. trends. *Education Week*, 64–67.

Price, W.J. (2004, January 7). New age principals. *Education Week*, *23*(16), 36–37.

Quality Education Data (1995). *Education market guide*. Denver, CO: Author.

Seeley Brown, J., & Duguid, P. (2002). *The social life of information*. Boston: Harvard Business School Press.

Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. New York: Doubleday-Currency.

Sergiovanni, T. J., & Starratt, R. J. (1998). *Supervision: A redefinition* (6th ed.). Boston: McGraw-Hill.

Simon, H. A. (1945). *Administrative behavior*. New York: Macmillan.

Simon, H. A. (1957). *Administrative behavior* (2nd ed.). New York: Macmillan.

Simon, H. A. (1960). *The new science of management decision*. New York: Harper & Row.

Simon, H. A. (1979). Rational decision making in business organizations. *American Economic Review*, *69*, 493–513.

Simon, H. A. (1982). *Models of bounded rationality*. Cambridge, MA: MIT Press.

Watts, D. (2003). *Six degrees: The science of a connected age*. New York: W.W. Norton and Company.

*Webster's third new international dictionary of the English language* (1986). Springfield: MA: Merriam-Webster Publishers.

Wenger, E. (1999). *Communities of practice: Learning, meaning, and identity*. Cambridge, UK: Cambridge University Press.

Wilhelm, J. (2007). *Engaging readers and writers with inquiry*. New York: Scholastic.