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ABSTRACT

This paper summarizes an analysis in which disparate information tools and systems within the Milwaukee Public Schools (MPS), Wisconsin, were compared and contrasted from the viewpoint of whether or not those tools provide users with the unique functional requirements associated with using data in the context of decision making. MPS has a sophisticated and rich information environment with both an operational database and a relational data warehouse. In this study, the Quality School Portfolio (QSP) was introduced as a local database tool to increase schools' capacity for using data to inform decisions. The first section of the report presents an overview of the MPS information technology infrastructure. QSP must interface with and compete with the technology already in place in the MPS. The second section summarizes a four-dimensional framework that is used to describe how QSP compares with and contrasts with other information tools supported by MPS. The third section evaluates QSP and other MPS tools on the basis of functions considered important to the process of data-driven decision making in the MPS. The comparison of QSP to Brio Insight and Excel shows that QSP best meets the needs of users at the school level, and that many of its uses at other levels can also be performed by Brio or Excel. The potential niche for QSP is discussed. (SLD)

QSP AND THE MPS INFORMATION SYSTEM

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Overview

This paper summarizes an analysis in which disparate information tools and systems within Milwaukee Public Schools were compared and contrasted from the viewpoint of whether or not those tools provide users with an the unique functional requirements associated with using data within the context of decision making. The goal of this analysis is to better understand the way in which any single piece of technology will interact with its counterpart technology. In this sense, the goal is not a straight comparison of one tool to another, but to understand how multiple tools can be used together as a system to support data-informed decision-making.

MPS has a sophisticated and rich information environment, in which there are two main systems: an operational database and a relational data warehouse (Kimball, 1996). An operational database collects student data (attendance, grades, and incident referrals) in real time via classroom-based computers. The data warehouse is a relational database that contains operational data, as well as other types of data, such as state test results, historical data, and demographic data. Whereas the operational system is designed to collect real-time data, the data warehouse is designed to support the analysis and reporting of data. In conjunction with the district information systems, many schools maintain independent databases and tools. Our project introduced QSP as a local database tool to increase schools' capacity for using data to inform decisions.

This report, organized into three main sections, will provide the reader with a sense of the technical and user centered constraints that impact data use within schools. The first section, *A Review of MPS Technology*, presents the reader with an overview of MPS's information technology infrastructure and describes some of the important features of that infrastructure. Information flow within the district is also described. This section is important to this report's thesis because QSP must both interface with and compete with technology already in place in MPS. The second section, *An Information Tool Framework,* summarizes a four-dimensional framework (Thorn, Watson, & Zeyher, 2001) that is used to describe how QSP compares with and contrasts to other information tools supported by MPS. This framework is also useful for describing the overall nature of information tools and can be looked at as a high-level review of information systems technology. The third section, *Analysis of QSP in the context of MPS,* evaluates QSP and other MPS tools on the basis of functions we consider important to the process of data-driven decision-making in MPS.

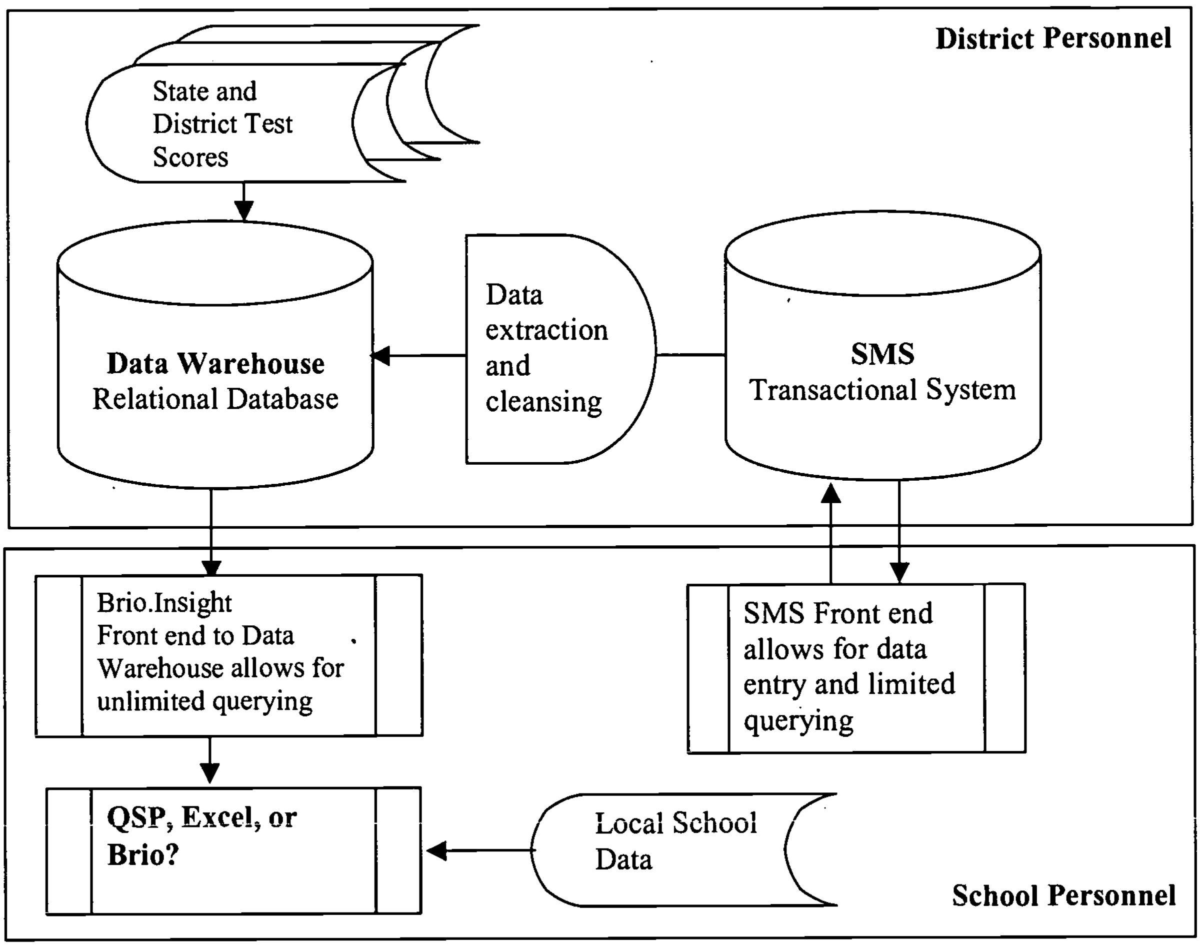
A Review of MPS Technology

It is important to note that MPS has a number of information systems that serve the district. This section describes the two most important systems and how information flows between them. MPS has adopted a two-prong approach that is typical of business information systems solutions (Figure 1). The School Management System (SMS) is responsible for collecting and storing up-to-the-minute information on students. The other system, the data warehouse (DW), is responsible for storing long-term information and supports the district's data analysis processes. There are two main entry points for data that are of concern. Classroom grades, attendance, and some incident referral data enter via SMS, whereas district and state test scores are imported directly into the data warehouse. In general, the information that is in SMS is imported to the data warehouse by the Technical Services Department. Once data are in the data warehouse, they can be exported, analyzed, or viewed via Brio.Insight.

The School Management System (SMS) is an information system that collects attendance data, incident data, and classroom grades in real time. Teachers enter data into SMS directly from the classroom and once entered, the classroom data can be queried and reported through the SMS software. Many of the reports provided by SMS attempt to provide schools with standard and predictable information tables, but ad hoc queries can also be created if an administrator needs information that is not already available through one of the standard reports.

In technical terms, the SMS is an operational database, or transactional system, which is designed to capture information each time a "transaction" occurs, such as the recording of a student's absence from his fifth hour algebra class. The name itself is a throwback to systems that were developed in the 1980s to link a business's point-of-sales (i.e., transactions) data to the company warehouse, shipping, and manufacturing systems (Kimball, 1996). There are several characteristics of transactional systems that are noteworthy. First, transactional data sets are considered "alive" because the data will change over time, usually over a very short period of time. This is true of the SMS because data are being added to the system continuously (at least, during school hours). The data in the SMS are also subject to being edited by users and database administrators. Consider the student who arrives late for his algebra class. The teacher may initially mark him as absent, but later change his absence to an unexcused tardy. Thus, anyone trying to view fifth-hour attendance data might see slightly different numbers depending on when he or she conducted a query.

Figure 1. This diagram illustrates how information flows among MPS information systems. Most data originate from either the SMS system (grades, attendance, and some discipline data), or from state and district test scores datasets. The data warehouse stores data for querying and analysis purposes.



Another characteristic of transactional systems that holds true for the SMS is that performance is optimized by dividing data across a number of data tables so that redundancy within and across tables is minimized. This means that transactional data are very hard to access, both in terms of knowing where a certain piece of data is stored and of being able to pull out large sets of data in a timely manner. In fact, getting data out of a transactional system requires the assistance of a database professional, using either a custom-written query program, or a prefabricated query program. Therefore, certain data queries can be well represented in transactional models, assuming that the data query is known ahead of time, does not change over time, and is reasonably small.

For the above reasons, the SMS is the entry point for much MPS data, especially data that are meant to measure students' daily and even hourly performance, such as attendance, classroom grades, and some incident data. Because of the way in which transactional systems are designed to collect and maintain real-time data, the SMS is not a good environment for analyzing that data. The reasons for this lie in the fact that data are spread out over dozens of data tables. Therefore, extracting data requires intimate knowledge of the contents of each data table in the system. Furthermore, SMS is not designed to handle the workload associated with district-wide data extraction and analysis. Therefore, MPS has implemented a second system, its Data Warehouse, to handle data analysis.

The data warehouse is an approach to information systems that uses a relational database management system. This is fundamentally different from a transactional database. First, a relational database will contain all of the basic data "facts" within a single data table. This table is then associated to other tables that define the important dimensions of that data. For instance, the basic fact table contains a list of students (identification numbers and names). That basic table would then be connected to other tables that contain dimensional information, such as attendance (days enrolled, days attended, and percent attended), student demographics (ethnicity, gender, home address, etc.), and test data. Some of these dimensions may have sub-dimensions, depending on the nature of the data. For instance, test data could be associated with specific types of tests and their subscores.

Another difference between relational and transactional databases is that relational databases are stable and do not change over time, as transactional systems do. Whereas in a given day, a transactional system may handle thousands or millions of data loads (updating the database by adding or changing information), each of which only affect a single record, a relational database will receive new or updated data only occasionally, but that data load will likely contain millions of records.

The benefit of a relational database is that it is designed to support querying and analysis. For this reason, the Data Warehouse has become the central database for MPS. Data are loaded into the Data Warehouse from a variety of sources, including SMS, testing vendors, and legacy mainframe systems. In terms of information flow, the Data Warehouse is where most MPS data resides until it is needed.

Since the Data Warehouse is designed for data querying and analysis (i.e., On-Line Analytical Processing or OLAP), the process of extracting data is relatively easy and very efficient. MPS has chosen to use Brio.Insight (version 6.0) as a front-end tool to access the Data Warehouse. Brio.Insight is simply a piece of software that provides users with a drag-and-drop interface to the data tables maintained in the data warehouse. Once data are extracted, users can also use Brio to sort data, make tables, and create figures (e.g., graphs and charts).

It is also important to note other features of MPS information systems. First, one should be aware that the above systems are designed to serve district-wide needs; they are not designed to handle data that an individual school might collect on its own (See Figure 1). Of the six schools we worked with, four committed resources to collecting, managing, and maintaining local data. Two schools used Accelerated Learner's STAR Math and Reading software to test students' individual progress in those subject areas. One other school was interested in maintaining more detailed data on student incident referrals. The fourth school was interested in maintaining in-house data on incoming students as well as on current students. This school devoted personnel to gathering and managing its data. As is evident, schools had the need to integrate local data with district data. Indeed, as will be discussed later, the need to integrate data that is not in either the Data Warehouse or SMS may be a significant feature affecting the overall usefulness of QSP in MPS.

An Information Tool Framework

We presented a four-dimensional framework for the comparison and evaluation of information tools in an earlier report to the National Institute for Science Education (Thorn, Watson, & Zehyer, 2001). The framework is intended to be useful in understanding how various technologies interact within the context of an educational setting, especially when the technologies are designed to accomplish the different goals or provide unique functionality. The first dimension, *user needs*, identifies specific user groups and the anticipated user requirements of an information tool or system. The second dimension, *data characteristics*, attempts to illistrate the different ways in which data can be treated by an information tool. The third dimension, *analytic tools,* presents the different ways in which data and information can be analyzed. This dimension is meant to distinguish among information tools on the basis of how they allow users to analyze data. The fourth dimension, *technical considerations*, identifies a series of technical differences that exist in information technology.

Using The Framework

These dimensions serve as a framework for understanding similarities as well as differences between information tools. Therefore, it may be that one might want to compare two or more tools that are designed to be functionally identical. In such a case, the goal would be to understand which tool best supports that functionality. Whereas in a case where two or more tools are very different from each other, the framework can be used to understand how these systems complement each other. The latter is more applicable to our experience in MPS.

It should be noted that QSP has been under development for a relatively short period of time and does not have the benefit of a commercial software development budget. For these reasons, it may not be fair to compare QSP to other tools that MPS personnel may use when working with data. However, it is fair to ask how QSP will interact with these tools. It is also fair to ask how likely QSP is to diffuse into MPS as an information tool. Understanding this interaction will lead to better understanding of how to improve MPS capacity to use data to guide decisions and future research.

User needs. This dimension identifies how an information tool meets the needs of a particular set of users. In general, there are four main groups, each of which has fairly distinct information needs. Table 1 summarizes those needs, as well as identifying the time frame within which each group is likely to be operating. Likewise, these groups are likely to differ in how they aggregate data across individuals. Members of a school's staff and administration are likely to focus on individual students or small groups of individual students when analyzing data, whereas district staff are more likely to report and analyze data that have been aggregated across a greater number of students.

Table 1
A Summary of Each User Groups' Needs by Data Characteristics

		Data Characteristics		
		Information of Focus	Average Time Frame	Average Level of Aggregation
User Group	Students and Parents	Classroom measures, Standardized tests	Daily	Single individual
	Teachers	Classroom measures, test scores	Daily	Multiple individuals, small groups
	School Administration	Mark period grades, Standardized tests, Longitudinal data, Local program data, Local budget and planning data, Federal compliance measures	Mark Period	Individual to school-wide
	District Administration	Standardized tests, District budget and planning, Federal compliance measures	Annual	Schools, district-wide groups

Data characteristics. This dimension refers to the way in which an information tool treats data in general. At the basic level, databases will contain a set of records (these are like the rows of a spreadsheet), each of which contains fields (columns). However, there are also additional characteristics that can improve the way in which data is stored, analyzed, or reported. Namely, *metadata,* which, defined as simply information about information, can be very useful in supplying users with definitions of data elements as well as information about when the data were created, last updated, and how those data possibly relate to other data. Metadata can also be useful in more sophisticated information systems for defining ways in which data can be aggregated—for example, across time or students.

Also, data has two characteristics that are dependent on the source, as well as on the information tool used to access it. Both characteristics have to do with how one aggregates data. Aggregating over time decreases the *temporal resolution*, such as reporting individual attendance for every semester rather than every week or each day. Aggregating across individuals increases the *granularity* of data—for example, reporting the percentage of students that has met a proficiency by school by grade. These characteristics are determined mostly by the manner information systems professionals decide to use to collect and store data.

Analytic structures. This dimension captures the various ways in which users of an information tool analyze data. Table 2 summarizes this information in a K-12 context. In general, the components of this dimension vary from simple to complex. The simplest form of analyses involves writing queries and reports and, perhaps, averaging over some arbitrary group of records, such as school or grade level. Slightly more sophisticated are

Table 2

A Summary of Analysis Techniques that Comprise the Analytic Structures Dimension

		Definition	Example
Analytic Structure	Queries and Reports	Generating a set of records and sorting those records in a meaningful way	Extracting a list of students who have yet to meet 8th grade proficiencies
	Aggregation	Summing or averaging over a basic unit of analysis	Reporting average WSAS test scores by school
	Multi-dimensional Graphing	Supports the graphical representation of multi-dimensional data	Bar graphs of a measure across grade, gender, ethnicity, etc…
	Statistical Analysis	Computational analysis that attempts to find statistically reliable patterns in data	*t*-Test, Analysis of Variance, Multivariate Analysis of Variance, Correlation, Regression
	Data Mining, Model Forecasting, and Prediction	Automated pattern detection and mathematical model building and testing	Factor analysis, linear systems analysis

multidimensional graphing techniques that allow the user to create graphical representations of data that have many dimensional attributes. For example, in analyzing WSAS test scores, one might choose breakdown test scores by gender *and* ethnicity *and* student reading ability, resulting in a three-dimensional graph. Furthermore, in more sophisticated information tools, the graph itself can be interactive, resulting in a dynamic representation of *n*-dimensions. Statistical analysis is a more complicated analytical approach that requires the user to be aware of issues relating to statistics in general (i.e., what is variance, reliability, power) and of issues relating to specific statistical measures and tests. Finally, some tools are designed to automatically analyze data sets for patterns that appear to be statistically reliable. These patterns may lend themselves to building a mathematical model that may be used to predict future data.

Technological considerations. This dimension of the information tool framework identifies several issues relating to the technical aspects of information systems. The first issue, usability, is a general design aspect that can be applied to all types of tools and systems. It is especially important when an end-user tool is being considered because the intended users are not likely to be highly skilled in the computer field. Usability is also an issue in that it can affect the cost/benefit ratio of a given tool. A system that is hard to learn or operate will lead to poorer end-products, while elevating the costs of operation (i.e., it requires more time or personnel).

Another distinction to make when looking at information tools is the implementation strategy of the tool. Whether or not a tool is designed as a stand-alone product or as a network application will impact the way in which an organization will utilize it. Network applications can be further divided into either client/server applications or web-based applications. Client/server architecture is the traditional application but may have special requirements relating to operating systems, licensing, and the site of the license installation. Alternatively, web-based applications are written to use web-browser platforms such as Netscape or Internet Explorer as a basis for the software. As such, these implementations tend to be platform-independent and more flexible in terms of when and where a license can be used.

Traditional information systems vary in their focus concerning data use. *On-line transactional processing* systems (OLTP) are designed to manipulate single records of data, such as updating a student's attendance for a particular hour. These systems can handle an impressive amount of real-time data, but are limited for purposes of data analysis. *On-line analytical processing* (OLAP) systems are designed to compensate for this limitation of OLTP systems. Here, analysis is emphasized and accomplished in a variety of ways (see discussion above on Analytic Structures). Also related to this issue is whether or not an information tool is designed to facilitate the everyday *workflow* of a specific school or district. Workflow management systems attempt to streamline and coordinate the process of using data. This aspect of information technology would only be present in very large-scale implementation strategies.

Other issues include *performance* and *system requirements*. Both of these issues may be specialized, depending on the type of tool being considered. For example, Microsoft's Access is fairly limited in terms of database size. Thus, capacity would be considered a relevant consideration if it is expected that the database would exceed the limits of the system. Conversely, performance issues only arise during the analysis of very large data sets.

Analysis of QSP in the Context of MPS

As has been indicated in the previous sections, MPS maintains a sophisticated set of information tools and systems. Furthermore, information tools and systems, in general, vary along many attributes. The focus of this section is to determine whether QSP will complement the technology already in place in MPS and, if so, specify how QSP will work within the pre-existing structure of MPS's information technology.

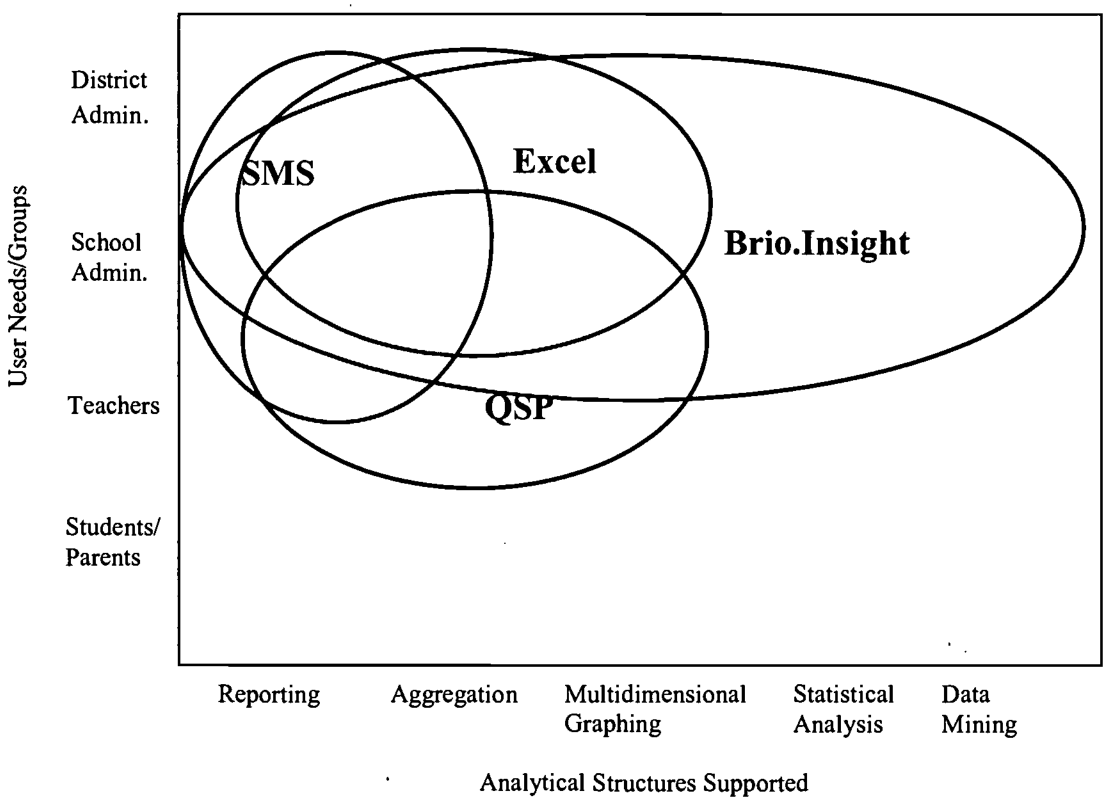
In order for QSP to successfully diffuse into MPS schools, it must accomplish one of two goals. QSP must either provide unique a functionality that is critical to the workflow of schools in MPS, or it must provide functionality that is already available but at a lesser cost than competing software. Cost can be measured in many ways and, for the most part, should not be measured in dollars. While monetary costs may impact the decision to *buy* a piece of software, it tends not to impact users' daily decisions regarding use of the software. Costs are more realistically measured by attributes such as time to learn, interoperability, ease of use, and software stability.

There are three main tools in MPS that are likely to play a significant role in schools' use of data: SMS, Excel, and Brio.Insight. QSP provides a fourth option. To summarize briefly, SMS is the interface with the district's transactional information system and provides functionality for data collection, some data extraction, and some reporting functionality. Brio.Insight is the district's query tool for the Data Warehouse, which also provides reporting, graphing, and analysis features. Excel is a powerful spreadsheet tool that can be used for data management, analysis, and reporting. QSP is designed for data management, analysis, and reporting.

This section is divided into two parts. The first part is concerned with detailing how QSP differs from Excel, SMS, and Brio.Insight. The second part is meant to provide a comparative evaluation of QSP, Excel, Brio, and SMS in terms of the critical functions required in data-driven decision-making.

The *Information Tool Framework* detailed in the previous section of this report facilitates a comparison and contrast of the four information tools. As expected, these tools vary in terms of what function(s) they are designed to provide. The framework indicates how the attributes of these tools overlap, allowing us to understand how each tool interacts with the other three. For example, the two dimensions, *User Needs/Groups* and *Analytical Structures Supported,* can be used as axes for a graph that represents what user group each tool is designed for and what analytical functions they support (Figure 2). This figure indicates that when it comes to targeting user groups and providing analytical support, there is a significant amount of overlap among the four tools. Most of this overlap occurs because all four tools target school administration, while providing at least some reporting, summary (i.e., aggregation across groups), and graphing functionality. However, this graphic also suggests that QSP and Brio.Insight offer more extensive functionality than both SMS and Excel. QSP also targets teachers, whereas Brio.Insight provides greater analytic capabilities.

Figure 2. A visual representation of the user groups targeted by QSP, Excel, SMS, and Brio.Insight and the analysis they support.



Setting the dimensions, *User Group* and *Technical Considerations,* orthogonal to one another creates a table in which each user group's technical needs can be specified (Table 3). In general, there are five technical aspects that can be considered significant: *usability, implementation strategy, OLAP vs. OLTP, capacity,* and *data integration.* Table 3 also details whether or not each tool can meet the minimum requirements for each user group.

Usability is an important design feature because it will impact the everyday use of a software tool, as well as the efficacy of its usage. Also, due to work loads and technical skill sets, it is likely that teachers and students/parents will have more stringent usability requirements than school and district administrators. Administration will in all likelihood have support personnel and other resources to help in overcoming usability issues, should they arise. Of the four tools, only Brio.Insight provides an interface that is expected to be usable on a wide scale by teachers (see Table 3). This is primarily due to the fact that Brio allows for three levels of users, administrator, analyst, and consumer, so that once a report or analysis has been generated, it can be dynamically viewed (but not necessarily edited) by other users. In this way, users with minimal skills can access and explore data that is specific to their work domain.

Table 3
Summary of Technical Considerations Across User Groups

		Technical Considerations																			
		Usability				Web-based				Analytical Focus				Capacity				Data Integration			
		QSP	Excel	SMS	Brio	QSP	Excel	SMS	Brio	QSP	Excel	SMS	Brio	QSP	Excel	SMS	Brio	QSP	Excel	SMS	Brio
User Group	District Admin	✓	✓		✓				✓	✓	✓		✓			✓	✓				✓
	School Admin	✓	✓		✓				✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓
	Teachers				✓				✓	✓			✓	✓	✓	✓	✓	✓	✓		
	Students/ Parents	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a					✓	✓	✓	✓				

Table 3 also indicates that only Brio.Insight uses a *web-based* implementation strategy. This is important for two reasons. First, it supports both Apple and Windows users. This is very important at the school level, where many users prefer the Apple platform. A web-based implementation also encourages the centralization of data, which makes the task of data management more manageable. QSP and Excel are both stand-alone applications, requiring the maintenance of data on each computer that is used. SMS employs a traditional client-server implementation that is better than a stand-alone implementation, but still limiting because users must use computers on which the client software has already been installed.[1]

The next technical consideration is whether or not the tool supports an *analytical focus* in data use. QSP and Brio provide good support for data analysis because their interface designs encourage the user to utilize several graphing functions to analyze data. Excel also provides good support for analysis of data through graphing functions, as well as through supporting advanced statistical analysis. SMS does little to encourage analysis; a query to this system results in a list of students, which would then need to be analyzed by some other software package.

In terms of data *capacity*, both SMS and Brio can handle the amount of data required at the district level, but only Brio is a realistic query tool for exploring data. This primarily stems from the fact that SMS is a transactional system, whereas Brio is considered an OLAP tool. Both Excel and QSP share similar capacity limits. Excel spreadsheets can have no more than 65,536 records (rows) and 256 fields (columns).

[1] Web-based software such as Brio also requires locally installed software. This software is downloaded when the users access the server through a web-browser, effectively making the server accessible from any machine with a Web browser and Internet access.

QSP, which is based on Microsoft's Access database management system, is limited to 255 or fewer columns. Likewise, QSP is also limited to a total of two gigabytes for each database and one gigabyte for each record set. Both Excel and QSP are adequate for school and classroom analyses; however, the column limit reduces the effectiveness of both software packages for district-wide data sets. For example, a data file containing demographic information for MPS will contain over 100,000 records, less than 40 fields, and require well over 10 gigabytes of space. Another example is the data set for the Wisconsin State Assessment System's TerraNova test. The data set supplied by the test vendor will contain over 300 fields and, as MPS shifts towards annual testing, almost 100,000 records.

It should be noted, however, that both Excel and QSP allow the user to select the fields to import, which minimizes the negative impact of each tools' field limit. Both import wizards utilize a set of dialogue boxes that guides the user through each step required to import data. Excel's wizard consists of three boxes, each with a "back" button that allows the user to move backwards through the process if a mistake is made. QSP uses five boxes, none of which have a "back" button (Appendix 1). Excel also supports the use of multiple delimiters, as well as an interactive drag-and-drop interface for defining field borders. While QSP is not as flexible as Excel in allowing users to manipulate multiple delimiters and field borders, it does have an "ignore rest" button. This is very helpful in that often the user may only want to import a few of the fields contained in a data file. This allows the user to quickly discard unwanted information.

However, in our experience, successfully importing data from a very large data set into QSP is often difficult because the process is prone to errors. The source of these errors is unclear, both to the end-user and to us as technical assistance providers. Furthermore, the error messages presented by QSP do not provide users with a solution path. Instead, the user must try to deduce both the problem and solution. We have found that adding a field containing a dummy variable to a data set will sometimes solve import errors, but this must be done via another software package (e.g., Excel) and can be problematic if the data set is large.

The last technical consideration represented in Table 3 is *data integration*. This issue addresses the problem of integrating data from multiple sources, including district information systems, school data systems, test vendors, and others. At the current time, it is unclear whether Brio can be used to look at local, non-district-based data sets. An example of such a database would be a collection of behavioral data, or test data that is generated by an in-school assessment system. As Table 3 indicates, QSP and Excel are more likely to be useful at the school and classroom level than Brio or SMS. QSP has an additional edge over Excel in that it will automatically join data sets through students' identification numbers.

As stated at the beginning of this section, we predict that QSP must meet one of two conditions if it is to successfully diffuse into MPS schools. QSP must either provide unique and necessary functionality, or it must provide redundant functionality at less cost than other information tools. At best, QSP *may* meet the first condition, depending on the specific needs of each school. Namely, QSP may provide schools with the unique ability to integrate local data with district data. Also, QSP may provide unique support for classroom-level analysis through its graphing and reporting functions, especially the analysis of local data.

As for the second condition, that of supporting data-driven decision-making processes more effectively than competitive information tools do, QSP probably does not succeed. Table 4 represents key functions considered important in data-driven decision-making for MPS employees. In each column, a check appears if the software provides support for that function. A check-minus indicates either that the software does not support that function very well (i.e., technically inadequate), or that there are usability problems (i.e., poorly implemented). Conversely, a check-plus indicates that the software does a good job at supporting that function, whereas a check indicates that the software meets the basic criteria for that function. An "X" indicates that the software does not support that function. Assigning 0 for each "X", 1 for a check-minus, 2 for a check, 3 for a check-plus, and taking the average, it is possible to calculate an overall rating. If certain functions are considered more important than others, those can be given a higher weighting in the overall score. The last column in Table 4 lists the weightings that we

Table 4
Comparative Analysis of Key Data Functions

Function	QSP	Excel	Brio	SMS	Weighting
Exporting Data	✓	✓	✓	✓-	5
Importing District Data	✓-	✓+	✓+	X	10
Importing Local Data	✓	✓+	X	X	10
Query Data Warehouse	X	X	✓+	X	7
Sorting	✓+	✓-	✓+	✓-	10
Grouping	✓+	✓	✓	✓-	10
Pivot Tables	X	✓+	✓+	X	7
Individual Student Reports	✓+	✓-	✓	✓-	10
Bar Charts	✓+	✓	✓	X	7
Pie Charts	✓+	✓+	✓+	X	7
Tables	✓+	✓+	✓+	X	7
Cross-tabular Tables	✓+	✓	✓+	X	7
Editing Graphs	X	✓+	✓+	X	7
Statistical Analysis	✓-	✓+	✓	X	5
Equally Weighted Average	1.9	2.2	2.4	0.2	
Weighted Average*	2.0	2.2	2.6	0.3	

Note: The overall rating was calculated by assigning a value of 3 for each ✓+, 2 for each ✓, 1 for each ✓-, and a 0 for each X.

have assigned to each function and the last row in the table reports the weighted average using those weightings. As can be seen, QSP and Brio both score a little higher with the weightings in place, but the relative scores of all the tools remained the same.

Table 4 further shows that QSP does not support any function that is not also supported by either Brio or Excel. In addition, there are two functions that QSP supports poorly, *importing data* and *statistical analysis*. This does not mean that QSP cannot be a viable and useful tool in MPS, but it does present some challenges. QSP might still fill a niche in some MPS schools that have a high need for importing local data, working with "sortable" groups of that data, and having a low need for editable graphs. Also, QSP provides reporting functions for individual students. However, Brio could also be used to generate similar reports, though doing so would probably require greater expertise than QSP. Likewise, Excel can leverage the scripting language of visual basic to generate batch reports, but again, doing so requires a high level of expertise.

For example, QSP may be useful in schools for looking at in-house data that are not in the Data Warehouse. The key to this will lie in the degree of difficulty encountered in importing data into QSP. For example, two of our schools were interested in importing test data from the Renaissance Learner™ STAR MATH® and STAR READING® software (see http://www.renlearn.com/default.htm). However, this software does not support the exporting of data into tab- or comma-delimited text files. Therefore, we helped these schools develop a way of exporting data that involved printing data to a post-script file.[2] This method required using Excel to clean up extraneous information, such as page headers and misaligned columns. Overall, the process involved importing from the STAR software into Excel and then into QSP. Some schools reported that it was easier to use Excel only.

Summary and Conclusions

Milwaukee Public Schools provides a complex and advanced technological environment in which to study the impact of QSP on data-driven decision making. The nature of information flow within MPS presents schools with several challenges in working with data. District data sets are large, and data are often available in non-flat file format only, requiring users to posses sophisticated computer skills to make the files transferable and usable. In addition, MPS information system hardware and software are still under development and implementation, and the value of district data is still being investigated and developed. Given this complex technological environment, this report has tried to summarize the major benefits of QSP and how those features interact with the technology already in place in MPS. The beneficial features of QSP—its capacity for importing data, grouping data, and graphing data—are in fact very important to data-driven decision-making. It is at the school level that QSP best meets the needs of users. However, as demonstrated throughout this report, many of these features can be replicated in either Excel or Brio. Furthermore, Excel and Brio are *required* in many data activities for MPS schools. Brio is needed for accessing data stored within the data

[2] A post-script file is a file that contains special formatting instructions. These are most often associated with either a printer file or an adobe .pdf file.

warehouse, whereas Excel is needed for manipulating and cleaning local data sets. Both of these tools are useful in flattening or cleaning data sets so that they can be analyzed more easily.

The four-dimensional framework is useful in understanding how various information tools compare and contrast to each other. It is also useful in describing or categorizing information tools, as well as in guiding more detailed comparisons. This framework appeared to be particularly useful when demonstrating how QSP differs from Excel, Brio, and SMS in terms of meeting *user needs*, *analytical structures*, and *technical considerations*. *Data characteristics* are primarily determined by factors other than the end-user tool, but even so, the data characteristics of a data set can affect the goodness of fit for a particular tool when that tool has limited capacity. Overall, the framework proved useful in establishing a model for a contextual analysis of QSP.

The diffusion of QSP within MPS will be limited by three factors. First, there are few features provided by QSP that are not also supported by either Excel or Brio. This minimizes the necessity of adopting QSP as a regular information tool. In addition, QSP ranks, at best, as no more effective than Excel and less effective than Brio in how well it supports the basic functions related to data use in MPS. Finally, some of the problems associated with QSP's import wizard and graphing modules may *require* users to use either Excel or Brio. Ideally, the use of QSP should lead to the decreased use of other tools.

However, QSP may yet be useful to schools that place a high value on working with local data, or that have solved many problems relating to importing data into QSP. This would be much more likely in smaller school districts where test data files are not so massive, which would minimize many of the problems that MPS schools reported while trying to import data. In addition, QSP may find a niche in schools that place high value on producing individualized student reports.

In general, there are major issues to be confronted if we are to make the process of data-driven decision making more efficient. First, schools must have access to useful data that are formatted in a way that encourages data analysis. Schools must also learn how best to manage their data and information tools so that resources are maximized. Finally, schools must learn how to utilize data as a feedback signal so that school and classroom practices are improved over time. These problems are not entirely independent of the problems relating to QSP. QSP is, in fact, designed in a way that assumes that the user has access to clean and meaningful data. Therefore, it is not surprising that problems were encountered when schools tried to use QSP on data that was not formatted in exactly the right way. Indeed, schools that demonstrated the greatest success were the schools that devoted the most personnel to the problems associated with using data and that spent the greatest amount of time seeking meaningful pieces of information and knowledge in that data.

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