ABSTRACT

MARKER, KATHRYN CHRISTNER. Understanding How Principals Use Data Dashboards to Inform Systemic School Improvement. (Under the direction of Dr. Tamara Young.)

Because data access may be perceived by principals as overwhelming or irrelevant rather than helpful (Wayman, Spikes, & Volonnino, 2013), data access does not guarantee effective data use. The data-based decision making literature has largely focused on teacher use of data, considering less often data-based organizational improvements for the school as a whole with the inherent focus on the role of the principal. The purpose of this study was to articulate the theory of change (Carman, 2010; Weiss, 1997a) which underlies the connection between accessing data via a dashboard, and the successful use of data to inform decision making by K-12 principals in their schools. This study's research question asked what knowledge, skills, and dispositions contribute to effective use of data dashboards by principals for school improvement. To answer that question, basic interpretive qualitative methods (Denzin & Lincoln, 1994; Merriam, 2002) were first used to outline the nature of dashboard use according to experts in industries where dashboards have a longer history and a more robust data technology literature base than in education. Then, with a case study design (Creswell, 2007; Merriam, 1988; Stake, 1995) and a focus on a data dashboard implementation in North Carolina, this study elicited program theory from North Carolina stakeholders. Data from interviews, observations, and documents were analyzed to articulate a theory of change and create (a) a logic model (a visual diagram) of how the dashboard is expected to facilitate data access and result in effective decision making, as well as (b) a logic model illustrating the theory-practice gap.

Results of the study led to recommendations specifically for principals, ranging from developing spreadsheet skills to leveraging dashboards for situational awareness (Few, 2013;
Marzano, Waters, & McNulty, 2005). In addition, the findings suggest that education planners should seek a true dashboard and refuse to settle for an interface offering a single sign-on to multiple software products. Further, schools need a framework for the action subsequent to data-based decision making. In the discussion of these findings, the study highlights the connection of Professional Learning Communities (PLCs) to principals and dashboards and offers insights from the business research literature about process improvement. This study has implications not only for the professional development of principals but also for the improvement of dashboard technology implementations, and for an expanded understanding of the potentially transformative impact of dashboards on decision making.
Understanding How Principals Use Data Dashboards to Inform Systemic School Improvement

by
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A dissertation submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the Degree of Doctor of Philosophy

Educational Evaluation and Policy Analysis

Raleigh, North Carolina
2016

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ACKNOWLEDGEMENTS

My family has supported me throughout the Ph.D. journey. I am grateful to them for listening to my research ideas for the last six years.

Many thanks also to my advisor, Dr. Tamara Young, for her support and guidance. I have greatly appreciated her high standards and commitment to excellence.

I also appreciate the members of my committee and their willingness to serve: Dr. Jenifer Corn, Dr. Lance Fusarelli, and Dr. Brad Mehlenbacher. Thank you very much.

Finally, I would like to thank the industry experts who generously agreed to speak with me. Without them, the insights of this research would not exist. I am also grateful to North Carolina's incredibly busy educators on the front lines of school improvement efforts for the time they graciously offered to this research project. My hope is to contribute to professional development for K-12 principals, the Chief Executive Officers in public schools.
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INTRODUCTION

Data-based decision making is widely touted as a central component to school reform (Bernhardt, 2004; Copland, Knapp, & Swinnerton, 2009; Kowalski, 2009; Marzano, Waters, & McNulty, 2005; Militello, Rallis, & Goldring, 2009). To achieve meaningful and lasting reform, school staff must engage in thoughtful data analysis and collaboratively seek solutions to their own local problems (Earl & Katz, 2006). The central player in the decision-making process is the school’s leader, the principal, who not only facilitates data analysis on the part of the school staff, but also monitors school data to ensure the climate is conducive to productive classroom instruction (Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010).

While student achievement is largely associated with the interaction between students, teachers, and the curriculum, schools must be organized to support effective instruction. That is, the overall school environment encourages or constrains the crucial work of teaching (Bryk, et al., 2010). One important approach to creating a school environment that supports effective instruction is data-based decision making, an approach ideally improved by dashboard technology.

Data Dashboards

Sometimes known as a management information system (MIS), the technology which organizes and presents the enormous amount of information which schools collect has been a focus of school investment in recent years (Blau & Presser, 2013; Breiter & Light, 2006; Schmedlen, 2013). For example, with a Race to the Top grant from the federal government North Carolina has invested $140 million into technology projects centered around a new student management information system (Price, 2012). The new North Carolina technology motivates the study proposed here, but is surely a harbinger of projects to come in other
states. “Big data will be transformative in every sphere of life,” noted a report commissioned by the President of the United States (Executive Office of the President, 2014, p. iv).

The information management system in North Carolina known as Home Base consists of a number of software applications (both new and updated) and offers school personnel an integrated platform, or one interface with multiple sources of information. States and districts adopting a management information system and a dashboard interface expect this technology to improve decision making and subsequently increase student achievement, as is the case in North Carolina (“CCRESA Meeting,” 2013; Price, 2012). The hope is that the technology upgrades will directly impact teachers and classroom instruction, and in addition will change the nature of data-based decision making for principals.

**Purpose of the Study and Research Question**

This study examines the theory of change underlying data dashboard use by school principals in order to determine the knowledge, skills, and dispositions they need to effectively use dashboards. Because the tool and its use are so different from previous technology adoptions, the theory of its impact on decision making merits attention. Data dashboards in general provide more data, more completely, and in a more straightforward, accessible manner than previously known.

Data dashboards are fairly recent additions to K-12 decision-making. Limited research exists which explores their use, which leads to limited understanding of how to improve participants’ interaction with them. In a school setting, states are investing in technology with long-term goals including improved student achievement. These technology investments affect numerous stakeholders in a variety of roles who will interact with dashboards. The short-term outcomes must be understood before long-term outcomes such as
increased student achievement can reasonably be targeted for evaluation, and before the impact of the technology can be fairly assessed. As shown in Table 1, short-term outcomes exist for different stakeholders at different levels. However, those for principals at the school level are the focus of this study.

Table 1

*Overview of study focus relative to the range of stakeholder outcomes described in Price (2012)*

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Short-term outcomes</th>
<th>Long-term outcome</th>
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<tbody>
<tr>
<td>State / districts:</td>
<td>Improve administrative functions with updated and coordinated technology tools</td>
<td></td>
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<tr>
<td>Schools:</td>
<td>Improved decision making: more effective planning, monitoring, and evaluating of school programs; more effective oversight of instruction</td>
<td>Increased Student Achievement</td>
</tr>
<tr>
<td>Teachers:</td>
<td>Better and more efficient instructional data-based decision making; increased access to instructional resources</td>
<td></td>
</tr>
<tr>
<td>Students:</td>
<td>Access to academic support resources; customized instruction; “collaborative work areas” (Price, 2012, p. 14)</td>
<td></td>
</tr>
<tr>
<td>Parents:</td>
<td>Access to academic support resources for their students; improved communication with schools</td>
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**Two Areas for School Improvement**

School improvement in this study refers to local school efforts (as opposed to district initiatives) and school-wide efforts (as opposed to classroom or purely instructional data-based decision making). The focus is on two principal responsibilities, as depicted in Figure 1. The first principal responsibility is organizational management, enabling effective classroom instruction across the school. Without attention to systemic and organizational issues, instructional data-based decision making is destined to flounder, for it exists and thrives only within the larger context of the school as a whole (Bryk, et al., 2010).
The second aspect of principal responsibility classified here as school improvement is the planning of academic programs or special services at the school level. For example, how does the school implement the School Improvement Plan? Likely, it entails the planning and implementation of a major school-wide initiative. These efforts should be monitored and evaluated according to the tenets of data-based decision making for school improvement. While classroom instruction has the most direct influence on student achievement, it will have increased and more consistent impact within the context of a well-organized school which is able to offer effective support services. Both aspects of school improvement outlined here affect student achievement in significant ways (Bryk, et al., 2010).

The data dashboard will be a disruptive tool for most North Carolina principals (Price, 2012). Previously, they accessed numerous individual programs and tools for information about discipline, attendance, and achievement. For example, the former North Carolina student information management system (North Carolina Window of Information
on Student Education, or NCWISE) incorporated student grades and attendance but no curriculum standards or instructional resources. Facilitating access to the extensive data collected in schools is central to an effective data-based decision making capability (Picciano, 2009). In North Carolina, according to the state’s 2012-2014 Summary Information Technology Plan, Home Base “applications compose an integrated whole” where “accessibility of data and reporting will be simplified, more useful, and easier” (Price, 2012, p. 13).

Data Practice in Schools

The focus of this study is the use of data dashboards for decision making by K-12 school principals. That is, this research will focus on practice in schools, defined by Spillane (2012) as a pattern of activities, including both typical and ongoing activities as well as those resulting from the data technology as an intervention. It is essential to understand how principals use “data in practice” (Spillane, 2012, p. 118). The term data use, like school improvement, can at times be dissociated from meaningful insights due to overuse in imprecise contexts. Spillane’s (2012) approach, discussed more extensively in the next chapter, will ground this proposed research in tangible school data use. A focus on practice will facilitate an examination of how dashboards impact principals’ decision-making process, and thus develop an understanding of what principals need for effective use of dashboards.

In order to expand the understanding of data dashboard use in education and provide information to states implementing dashboards, this research is structured as a qualitative case study designed to articulate the theory of change underlying the dashboard technology's expected impact on principals’ data use. The results are presented as a visual diagram, or logic model, that explicates dashboard use by school principals and the process which leads
to improvements in data-based decision making related to systemic school improvement. Systemic in this context refers to organizational management and program planning in schools, as opposed to strictly instructional improvements. One research question guides this inquiry:

**Research Question:** What knowledge, skills, and dispositions contribute to effective principal use of data dashboards to inform systemic school improvement?

**Conceptual Framework**

Cousins and Leithwood (1993) equate a “top-down” approach toward school improvement to evidence-based solutions imposed on a school without consideration of local expertise, and a “bottom-up” approach to local experts assuming control of improvement efforts without evidence. Schools need both local expertise and data, or evidence, to enact effective, lasting school improvement (Kowalski, 2009). As such, “the school is the unit of knowledge use and change” in educational reform (Cousins & Leithwood, 1993, p. 306). This assumption drives the choice of principal data-based leadership at the local school as the level of focus in this study.

The school-level focus is built around the concept of knowledge utilization, centering the research on the users and keeping in focus the need to offer them an interface with data which will increase their ability to interpret, react to, and subsequently use that data (Petrides & Nodine, 2003). A first necessary component of knowledge use is “psychological processing” (Cousins & Leithwood, 1993, p. 309), meaning that for knowledge to be used, users must initially attend to it. This initial processing will be significantly influenced by four characteristics of the information itself (sophistication, relevance, timeliness, and content).
The change in knowledge utilization as a result of data technology can be understood through the impact of improved “psychological processing”.

Two constructs from the setting that are also significant are the information needs of the user, and user receptiveness, or attitude. The latter construct reinforces the understanding that successful principals not only have appropriate knowledge and skills, but also dispositions which lead to effective data use. Four interactive processes further explain knowledge use: social process, engagement, involvement, and ongoing contact (Cousins & Leithwood, 1993). Data use, then, is not a singular event which can be isolated to an individual, but a process, a collaboration, or a social endeavor (Brown & Duguid, 2000; DuFour & Eaker, 1998; Leithwood, Aitken, & Jantzi, 2006). Examining data use in the sense of knowledge utilization requires a nuanced look at principals’ interactions with information.

**Overview of Research Design**

This study is a theory-based evaluation, which is a study of the “beliefs and assumptions underlying an intervention” (Weiss, 1997a, p. 501). Weiss also noted the “four basic sources of information about the program’s theories: documents, people, prior research, and logical reasoning” (p. 508). Seeking out information from these sources leads to articulating the logic of the intervention. Additionally, examining the reality of the intervention in practice establishes a baseline of shared understanding among stakeholders, and lays the groundwork for future evaluations of implementation or impact.

Although the North Carolina Home Base project motivates the study, and the state's program planners and technology vendor, as well as North Carolina principals, play a large role in building an understanding of dashboard tools, the research began by seeking a more broad understanding of dashboard change mechanisms. The design for the initial research is a
basic interpretive qualitative study (Denzin & Lincoln, 1994; Merriam, 2002). Experts in industries where dashboards have a longer history were asked to lay out in broad strokes the nature of dashboard use for data-based decision making. This constituted Phase 1 of the study. Analysis of the results led to the creation of a dashboard use model according to the perspective of experts in other industries.

Then, moving to the North Carolina context which motivates the research, the design becomes a case study (Creswell, 2007; Merriam, 1988; Stake, 1995) in order to demonstrate how a theory of change can be used to inform principals’ current use of data dashboards for school improvement. The case study serves as a opportunity to shed light on the theory-practice gap with the program (Home Base), and helps North Carolina stakeholders “draw out the theory represented in their actions and assumptions” (Rossi, Lipsey, and Freeman, 2004, p. 148). The DPI Home Base team was tapped for their understanding of the Home Base project. Documents created by DPI to explain Home Base to North Carolina schools as well as to the general public were examined. The researcher also observed training where state leaders demonstrated the use of Home Base to practicing principals. Additionally, the main technology vendor, Pearson PLC, was asked to flesh out the decision-making possibilities their product affords educators. Interviews continued with practicing North Carolina principals. This constituted Phase 2 of the study. Analysis of the interview and observation data, as well as document analysis, led to the creation of a North Carolina model of dashboard use.

The final product of this study will include discussion of the differences between the Phase 1 Model and the Phase 2 Model, in order to provide insight into improving North Carolina’s approach as well as to inform the professional development principals need. This
type of data presentation may help “integrate evidence into thinking about program theories” (Sridharan & Nakaima, 2011, p. 139). In this way, data-based decision making may become not only the professional expectation for public school principals, but equally so for educational leaders and planners.

**Significance of the Study**

The data-based decision making literature has largely focused on teacher use of data, addressing instructional improvements and classroom-level changes (e.g., Mokhtari, Rosemary, & Edwards, 2007; Stecker, Lembke, & Foegen, 2008). The literature on data-driven decision making has neglected to fully consider data-based organizational improvements for the school as a whole with the inherent focus on the role of the principal. The various categories of school organization combine for a significant impact on student achievement; for example, routinization of classroom innovations (Bain, 2007), efficient management of school time (Bryk, et al., 2010), facilitation of teacher collaboration (DuFour & Eaker, 1998), leadership of the teachers’ implementation process (Hall, 2010), modeling the use of educational technology for teachers (Militello & Ersozlu, 2013), student scheduling and teacher assignments (Hallinan, 1987), and creation of a school community (Stewart, 2007). Thus, principals’ data-based decision making has the potential to improve institutional effectiveness by influencing these categories of school organization.

Training with the goal of improved data literacy is a likely starting point for principals’ professional development. The education literature includes numerous manuals for staff data analysis. The Earl and Katz text (2006) is subtitled *Harnessing Data for School Improvement*. In *Data Analysis for Continuous School Improvement*, Bernhardt (2004) included meeting protocols, surveys, and analysis rubrics in the appendices. *Data Wise*, by
Boudett, City, and Murnane (2005) is a step-by-step guide to instructional data-based decision making. These are excellent handbooks to develop data literacy, which is defined by Earl and Katz (2006) as encompassing not only statistical expertise but analytical and communication skills. Obstacles to practitioner data literacy are explored thoroughly in the literature. Lasley (2009), for example, listed several factors which inhibit data literacy, including data overload and limited technical expertise. Lack of time amid pressing daily obligations (Boudett, et al., 2005; Copland, et al., 2009; Corn, Byrom, Knestis, Matzen, & Thrift, 2012; Datnow & Park, 2009; Lasley, 2009; Wayman, Spikes, & Volonnino, 2013) is also an obstacle facing school-based staff. If indeed practitioners can hardly focus on any activity not essential for daily survival, how then can they “do reform on the fly”? (Bain, 2007, p. 168). While these limitations are very real, and dashboards are no magic bullet for school improvement, dashboards do have the potential to mitigate the problems preventing effective data use (Wayman, Stringfield, & Yakimowski, 2004).

Even though a fair amount of existing research addresses the improvement of educator data literacy, data literacy among the nation’s educators in general has not been systematically investigated and the varied needs of practitioners (teachers and administrators, or novices and experts) have not been effectively explored (Mandinach & Gummer, 2013). Professional development tailored to the unique responsibilities of principals requires an understanding of what different groups of educators need for effective “analysis, interpretation, and decision making” (Bettesworth, Alonzo, & Duesbery, 2009, p. 301). Even beyond interpreting data well, however, is the need to make decisions based on their understanding of the data. Professional development does not typically address this second need effectively. As new information management systems are put into place, for example,
schools are more likely to train employees on how to use the tools themselves rather than how to make meaningful changes based on the data (Ronka, Lachat, Slaughter, & Meltzer, 2008; Wayman & Cho, 2009).

While the potential of data dashboards powered by a robust information management system promises much for public schools, ultimately data tools are just that: extraordinary tools, inert without effective use. Schools must frame their technology tools within what Fullan (2001) identified as the overarching purposes of education. First and foremost, educators need to make a difference in students’ lives; second, they must understand the change process; and finally, Fullan noted the significance of human connection, saying that “data without relationships merely cause more information glut” (p. 6). Without effective principal use, these data dashboards (such as Home Base in North Carolina) will add to the cacophony of competing school initiatives and hinder, rather than accomplish, the purposes of education.

The concept of data literacy has evolved from a basic understanding of statistics to a fuller awareness of program evaluation (Corn, et al., 2012; Guerra-López & Toker, 2012; Hemsley-Brown, 2009; Huffman & Thomas, 2009). Data literacy in the sense of understanding graphs and grasping the meaning of student achievement depicted on charts remains vital, however, facility with spreadsheets or agility with data representation alone are insufficient for school improvement. Principals must develop their capacity for understanding data further, to the point of effectively planning, monitoring, and evaluating the actions brought about by their data-based decisions. Principals oversee numerous school-wide programs (remediation or enrichment programs, for example) which consume significant staff time and school resources, therefore the question of principals’ evaluative
capacity, or their ability to make solid data-based decisions, merits the attention proposed by this study.

Data use is heavily promoted in education, and enormous investments are being made not only by the public sector but by private foundations as well (Coburn & Turner, 2012). However, Coburn and Turner cautioned that “empirical research on data use continues to be weak” (2012, p. 99), and highlighted the weaknesses of traditional approaches to data use research, including studies of the nature of the intervention (without examining the interaction of personnel with the intervention) and handbooks which focus on how to structure data analysis. Emphasizing the importance of understanding “when and under what conditions data use acts as a productive pathway” (p. 100), Coburn and Turner recommend a stronger focus on data use practice, or what actually happens when school personnel interact with the data in their unique professional context. With a focus on data use practice by public school principals, this study proposes to articulate “when and under what conditions” data dashboards will enable improved decision making, thus leading to a more solid understanding of the knowledge, skills, and dispositions necessary for principals’ use of dashboards to inform school improvement.

Framing this study as a type of program evaluation—program theory evaluation—not only accomplishes the stated goals of discovering how data dashboards are intended to impact public school principals, and also therefore what principals might need to profit from them, but also engages stakeholders in the evaluation itself. “A successful theory-articulating process is generally interactive,” noted Weiss (1997a, p. 509). A logic model “builds a shared understanding of what the program is all about and how the parts work together” (W.K. Kellogg Foundation, p. 6, 2004). This theory-articulating process is not an exercise by the
researcher as an outsider for external purposes, but as a shared work meant to offer a data-based mentality to stakeholders.

**Practical Significance**

The most immediate practical significance associated with this study is the potential positive impact on the implementation of Home Base in North Carolina. In 2013, the entire state transitioned to PowerSchool, the key student information software of Home Base. Several other products (e.g., the teacher evaluation program) are being phased in across the state, and still others will be offered for a fee, with Home Base therefore taking shape differently across North Carolina. Even in a clearly defined implementation (which Home Base is certainly not), the comparison of users to non-users would be misleading. Hall (2010) characterized researchers who attempt to compare a treatment group (those adopting the technology) to a control (those without the technology) as a false dichotomy. Hall’s point was that implementation is a continuum and categorizing users as adopters or non-adopters of a technology is overly simplistic. Fixsen, Naoom, Blase, Friedman, and Wallace (2005) noted that “implementation is a process, not an event” (p. 15).

Because implementation is not an either-or singular event, and additionally because Home Base is being implemented in different ways across the state, a study based on program theory, rather than an implementation evaluation, is most appropriate at this time. Program theory leads to an understanding of the sequence of events, allowing planners to operationalize the concepts which underlie their program (Weiss, 1997a). Articulating a program’s chain of events as a logic model informs the implementation or impact evaluations which follow (Carman, 2010). North Carolina, while it clearly needs insight into its technology adoptions, cannot currently benefit from an evaluation of its implementation.
This exploratory study, at the initial stage of Home Base implementation, proposes to explicate the products, the users, the context, and the program assumptions in ways that will facilitate the ongoing implementation.

The concept of data dashboards as a data-based decision making tool in public education is young and deserving of further development. In particular, practitioners need practical and targeted research information about advances in the data-based decision making field. School principals and other school-based staff will likely make better use of data dashboard systems for decision making when scholars writing about them understand the school context and the leadership needs (Biddle & Saha, 2006; Fusarelli, 2008). Studies which explain the perceptions of school principals (Militello & Ersozlu, 2013) give voice to principals so that researchers are better connected with the practitioners they hope to impact. The research proposed here contributes to the description of practitioners’ data culture and improves the process of school improvement by informing data-based decision making scholarship of the ongoing challenges of principals’ daily work lives.

**Theoretical Implications**

In addition to these many applied benefits of the research, valuable theoretical outcomes are expected as well. First, with a focus on the dashboard, this study will inform the burgeoning field of sophisticated data visualization possibilities in education. Second, much of the spotlight of school improvement literature has been on the micro level of classroom-based instructional initiatives, but the new efficiency of Home Base also holds great potential as a basis for improved school-wide management, as well as planning and evaluation at the school level. This study’s focus on the principal’s role will support the extant literature which examines the link between overall school strategies and student
achievement. Finally, this study’s approach via program theory will inform the literature on the development of logic models as a means of articulating a theory of change in an education setting.

**Limitations of the Study**

Not many schools have a fully adopted data management solution similar to Home Base. With few exemplars to observe, the pool of expertise in education is not large. Although other industries have a longer history of dashboard adoption and a more robust data technology literature base, the professional context typically differs substantially from education. However, qualitative inquiry is ideally suited for research seeking to articulate the complexities and nuances of a situation with few sites or individuals (Creswell, 2007) and further offers insight into underlying meanings (Merriam, 1988) which allow schools to profit from the knowledge base of other industries.

The staggered implementation of Home Base across the state limits research approaches to study the implementation process or Home Base effectiveness. In addition to the phased implementation, schools start at varying points of data literacy, and not all districts will eventually opt to implement each product offered by the state as part of Home Base. Despite these limitations, it is important to begin research at this early stage in order to prepare North Carolina’s schools for the massive technology shift which is occurring (for all schools to a certain extent) over the next few years. The state’s Summary Information Technology Plan (Price, 2012) notes that “implementation will be disruptive to school operations” and that “there are significant technical and instructional learning curve challenges” to be expected (Price, 2012, p. 3). Careful preparation for North Carolina staff professional development, and a more complete understanding of how principals elsewhere
have been successful with similar data tools, will set the stage for the most effective implementation process, minimizing the disruption and maximizing the benefits as quickly as possible.

In addition to these limitations of the local context, several concerns raised in the evaluation literature may impact this study. Leeuw (2003) warned of the consequences of inattention to “social and behavioral dynamics” (p. 9), a risk in a study largely dependent on data gathered via interviews from program stakeholders. It will be important to remain cognizant of these stakeholders’ positions and their professional motivations which may color their expressed views of the program.

Leeuw (2003) and Weiss (1995) noted that the political context heavily influences major programs, further complicating efforts to understand a program’s theory. The North Carolina technology project is likely to be a situation where one must be wary of political overtones. For example, the initial implementation of the major piece of software experienced numerous setbacks in the school year 2013-2014 (Hui, 2014). Although perhaps these problems are to be expected in a major technology rollout, practitioners are impatient about them, and state leaders may be defensive. In addition, the Home Base project may be tainted by the negative impression some people hold concerning data collection in general. Recently, the Obama Administration released a report about big data and individuals, addressing the digital privacy issues which increasingly worry Americans (Executive Office of the President, 2014). The research results must carefully present the value offered by data access to educators for school improvement, while not being cavalier about the risks and concerns.
Many of the interviews in this study will be with people who have a professional stake in the success of Home Base. Seeking their perspective of the program’s theory of change may result in the collection of what Taut, Santelices, Araya, and Manzi (2010) referred to as data which reflect wishful thinking. In other words, albeit seeking the actual causal events of the program, the interviews may elicit the hoped-for causal events, whether or not they are change mechanisms grounded in industry expertise or academic scholarship, or even professional experience. However, given the fact that the North Carolina implementation is in the early stages, the prospect of viewing the program through rose-colored glasses may be acceptable. To a certain extent, the development of a logic model is a way to bring “concepts and dreams to life” (W.K. Kellogg Foundation, 2004, p. 3). It will be the responsibility of the researcher, however, to discern the actual program plan and to hold it up to the light of scholarly research.

The goal of this research is not only to clarify the program design, but also to allow reality (Wholey, 2004) an opportunity to inform the ideal design, giving identified users (principals) a voice in the development of program theory. Operating with an awareness of the potential interview limitations, this study attempts to surface the program’s expected change model. Nevertheless, this research includes a close look at the reality of data dashboard program use and a search for literature which supports the identified change process. These two features reduce the likelihood of unrealistic results which delude rather than inform.

This study is designed for an examination of individual knowledge, skills, and dispositions; an investigation into the changes expected in a narrow context, that of principals making decisions for their local schools. However, while discussing the essential elements of
readiness for data dashboard use during the interviews, principals often refer to their environment: the organizational characteristics and resources available. Efforts were made to focus on individual capacity within the scope of the organizational characteristics and resources described. Specifically, this study has been delimited to the principal as a program participant and the individual knowledge, skills, and dispositions which facilitate the principal taking action based on insights from the data dashboard.

**Definition of Key Terms**

The Department of Public Instruction (*DPI*) directs kindergarten through twelfth grade (K-12) public schools in North Carolina.

*Home Base* is the term for North Carolina’s statewide data dashboard. The initial elements were implemented state-wide in the summer and fall of 2013, replacing the North Carolina Window of Information on Student Education (*NCWISE*), the previous student information system. Home Base will gradually encompass other resources and tools for schools (“Home Base Slideshow,” n.d.). Certain components of Home Base (the *PowerSchool* student information system, *TestNav* for summative assessment data, and the educator evaluation product) will be required and provided free of charge for public schools across the state. The North Carolina DPI is coordinating implementation and offers additional products to be integrated in Home Base for a fee (“Home Base Slideshow,” n.d.).

The domain of *program evaluation* frames the approach to the research question. A *program* is defined by the United States General Accounting Office as “any activity, project, function, or policy that has an identifiable purpose or set of objectives” (2011). In this study, the data dashboards offered to schools is the program. *Program evaluation* is defined by Rossi, Lipsey, and Freeman as the use of research methods to study interventions (programs)
so that “sound judgments can be drawn ... and the design, implementation, impact, and
efficiency of programs” can be better understood (2004, p. 2). In this study, a very narrow
slice of program evaluation will structure the research.

A theory of change is the explicit expression of the assumptions built into a program
(Weiss, 1995). The Annie E. Casey Foundation (2004) describes a theory of change as first,
an understanding of how change occurs, and second, documentation of stakeholder
assumptions integral to the change process. The theory of change is often visually articulated
as a logic model, or a “a systematic and visual way to present and share” an understanding of
the expected changes (W.K. Kellogg Foundation, 2004, p. 1).

A student management solution is at the heart of the value provided by North
Carolina’s new system. Home Base and other systems like it are “software packages [which]
generally consist of modules that can be purchased separately and address particular
functions such as school records, attendance, scheduling, and [academic] progress”
(Vecchioli, 1999, p. 3).

School improvement is defined here as a local school effort, geared to the school as a
whole, and encompassing both insight and action. Action, in this study, translates first to
organizational management of the school, and second, to planning and evaluation of school-
wide programs (Bryk, et al., 2010).

The principal refers to the leader of the local K-12 school.

Big data has become a hot topic in the corporate world. In a recent review of business
literature related to data analysis, Chen, Chiang, and Storey distilled the big data concept to
These terms all refer to the practice of collecting enormous amounts of information,
organizing it for efficient access, and building statistical models based on the data which then provide insight into emerging challenges.

*Actionable insights* is another business buzzword which refers to data informing action. A 2012 press release from Sales Engine International highlighted the expanded capabilities of a marketing performance dashboard which will help marketers extract actionable insights from volumes of data (“New Marketing Performance Dashboards”).

*A data dashboard* is a generic term for a user and computer system interface. It refers to the screen the user sees, which calls to mind the dashboard of a car (Few, 2004).

An *integrated platform* is a term for the combination of several computer applications, or software products. One of the goals articulated by the North Carolina Summary Technology Information Plan is “to form an integrated statewide administration and instructional technology platform” (Price, 2012, p. 6). A data dashboard can be described as an integrated platform, although researchers also describe a dashboard’s strategic possibilities (Kaplan & Norton, 1992) which give it influence beyond that of a basic platform or interface.

*Key performance indicators (KPIs)* are the metrics chosen to appear on the dashboard. These metrics represent the organization’s strategy (Allio, 2012).

North Carolina does not uniformly call Home Base a *dashboard*, referring to it overall as an *integrated platform* in the state’s technology plan (Price, 2012). However, when describing the school-wide analysis afforded by Home Base, presenters at a regional conference highlighted its function as a *data dashboard* (“CCRESA Meeting,” 2013). While these terms are often used interchangeably, some distinction will be helpful. A dashboard is a performance management tool (Allio, 2012), while an integrated platform is a generic,
technical term for an interface which coordinates access (“IBM platform management,” n.d.). An *integrated platform* offers convenient access to numerous systems, but dashboard experts argue that a *dashboard* communicates data more effectively and also represents an organization’s strategic plan (Eckerson, 2005; Few, 2013).

In this study, the term *dashboard* will be used to refer to the type of technology which has the potential to transform data-based decision making by educators, with the term *integrated platform* referring to less sophisticated, less transformative technology. This study assumes, based on publicly available Home Base documents such as the 2012-2014 Summary Information Technology Plan (Price, 2012), that North Carolina intends to provide schools with a *dashboard*, whether the state uses the term consistently or not. The features of a well-designed data dashboard are key to harnessing the power of information (Few, 2013). In theory, the terms *integrated platform* and *dashboard* represent different constructs even though in practice they are often used interchangeably. Because the ultimate goal of Home Base corresponds with the theoretical construct of *dashboard*, I intentionally use that term for this study. Yet, the results of this study should contribute to an understanding by experts and practitioners alike as to the nuances of the terms, and also provide insight on how we shift the discussion and practice towards the more transformative idea of *dashboard*.

**Overview of the Study**

Principals face a deluge of information and need to strategically use that information for school improvement. The organization and presentation of school data via a dashboard is expected to give principals, as instructional leaders and organizational managers (Grissom & Loeb, 2011), the ability to make more informed decisions. However, access to data will not directly improve schools, and the central question of this study seeks to discover what
knowledge, skills, and dispositions principals need in order to use dashboards successfully for systemic school improvement.

Following the introduction, Chapter 2 continues with a review of the literature in order to situate the study. The first section of the literature review explores data use among principals, and explains the choice of the principal’s role in the focus of this study. Then, literature which highlights how other fields manage data such that employees are not overwhelmed but instead enabled to lead more effectively is explored. Finally, the domain of program evaluation is presented, with an explanation of the timing and context of the North Carolina technology adoption which led to the choice of this study's focus on explicating a theory of change.

This research is designed overall as an interpretive qualitative study (Denzin & Lincoln, 1994; Merriam, 2002). Phase 1 begins the study with data from industry experts and dashboard literature. To demonstrate how a theory of change can be used to inform current use of dashboards in education, in Phase 2 the research uses North Carolina's Home Base as a case study (Stake, 1995). Chapter 3 explains these design choices and outlines the data collection and analysis, including a justification of the choice of data sources: interview participants, observations, and documents.

Chapter 4 describes the findings and presents logic models which depict the ideal use of dashboard technology in other industries, the intended or ideal use in the case study example, as well as the educational dashboard use reality. Findings are organized in terms of the inputs, or the factors which interact in the presence of data dashboards. These factors are people, data, product (the technology tool), and organization. People—their knowledge, skills, and dispositions—are the key input focus in this study; however, the work of people
with data is mediated by a technology product, and this work occurs in the context of an organization.

Chapter 5 discusses the themes arising from the research findings and recommends action steps for education leadership. These action steps include lessons for educators from industry as well as lessons from an examination of dashboards plans in education. The findings should influence the professional development of principals given the dashboard technology implementations happening in states like North Carolina. Policy makers in North Carolina as well as in other states will want to maximize their investment in dashboard technology. Recommendations stemming from an improved understanding of how data access leads to improved decision making will help.
LITERATURE REVIEW

This study examines how school improvement is expected to happen when principals have dashboard access to data from a range of sources, giving them instant information about what is happening in their schools. The results of this study will shed light on how principals can leverage data access and improve their decision making. Before the three main sections of this literature review, a case for a North Carolina focus is presented, briefly explicating the status of North Carolina’s technology projects and the potential impact on school improvement. Then, to situate the study in the research literature, a review is presented in three sections, as depicted in Figure 2.

![Figure 2. Organization of literature review.](image)

The first main section of the literature review describes the importance of school-level decision making, the key role of the school’s principal in data use, and research which has examined data use by principals. The second section presents relevant literature from outside education, including the concepts of strategic management through dashboard use in business and the developing field of data visualization. Dashboard use and data visualization have a shorter history in K-12 schools, thus less robust research evidence exists in the
domain of education. This section also includes a more detailed description of the actual technology (what makes a dashboard a dashboard), as well as a model of dashboard literature mapped onto the main thematic categories from Phase 1 of this study.

The third section of the literature review outlines the program evaluation perspective which shapes this study’s approach to the research question. In order to understand what knowledge, skills, and dispositions principals must have in order to successfully use data dashboards for school improvement, there must first be an articulated theory of change. This final main section of the literature review ends by defining theory of change and with an explanation of how a visual diagram, or logic model, represents the mechanisms which lead to a program’s outcomes. The chapter then turns to a short review of key concepts underlying the terms data use and data-based decision making. The chapter concludes with a translation of these concepts to a concrete approach for studying data use in schools.

**North Carolina Education Technology**

North Carolina schools are on the cusp of a new age in data use, prompted by information technology (IT) upgrades. This section explains why this is so, and how these IT changes may impact decision making for North Carolina's principals. The state's Department of Public Instruction (DPI) is in the midst of a series of massive technology improvements. Some DPI projects introduce new technology while others replace or update older programs. The 2010 Race to the Top (RttT) grant from the federal government encompasses most of the 30 projects which comprise the 2012-2014 DPI plan (Price, 2012). Among those 30 projects are the Home Base suite (which includes eight applications), additional RttT programs (e.g., a data integration service) which support Home Base, and a third category of RttT applications designed to improve internal operations at DPI. The Chief Information Officer at
DPI notes in the Summary Information Technology Plan (Price, 2012) that although each application has a unique and necessary function, “the real usefulness and true value comes from the composite package” (p. 11).

The overarching goal of the new North Carolina technology is to increase student educational outcomes by enabling innovations in classrooms and supporting teachers. The 30 projects outlined in the Summary Information Technology Plan (Price, 2012) aim to accomplish four objectives:

- Revitalize K-12 public education through innovative instructional methods and practices to improve student outcomes and educational program performance.
- Simplify instructional and administrative activities for school- and LEA-based personnel to increase productivity and work effectiveness.
- Consolidate and standardize NCDPI’s disparate mix of single-purpose legacy applications that presently use a variety of technical infrastructures. ...
- Collect, organize, analyze, and report data to provide information useful for decision making, allow for better management, and increase accountability. (p. 5)

**Discussion of DPI Technology Objectives**

The first two of the four objectives above relate to instructional innovations; in other words, a classroom-level focus. The coordination of instructional efforts, particularly in light of the changes inherent in the implementation of the Common Core standards (Phillips & Wong, 2013; Smith, Wilhelm, & Fredricksen, 2013) are understandably the priority of school district technology efforts. The third DPI objective refers to behind-the-scenes technology which makes all other projects functional. It is the fourth statement above which motivates this study, particularly the phrases “information useful for decision making” and to “allow
for better management”. This final objective relates to the data mining technology which has for some time dramatically influenced business operations in the corporate world (Chen, Chiang, & Storey, 2012; Kaplan & Norton, 1992; Leon, 2003) and is now certainly impacting the domain of public education. A recent United States Department of Education issue brief (Bienkowski, Feng, & Means, 2012) noted that “K-12 schools and school districts are starting to adopt institution-level analyses for detecting areas for instructional improvement, setting policies, and measuring results” (p. viii).

The potential for powerful decision making will impact a principal’s job in two ways. As noted above, the core work of a school occurs in the classroom. However, the principal influences how effective that instruction is, how much time is available for it, and how many or few problems detract from it (Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010). This is organizational management. Secondly, the principal, as the head of the school, controls the attention paid to school-wide academic services or supports and any solutions devised to improve them. The intent of this study is to shed light on the data dashboard and how principals will interact with it, thus leading to insights regarding the knowledge, skills, and dispositions of principals who are successful with that technology.

**Data Use by the Principal**

This section of the review presents literature which first examines the choice of the school as the level of focus, and then more specifically, the principal, who is the key player not only in the support of effective instruction but also as a manager of the school. The school is described as "the unit of knowledge usage and change" by Cousins and Leithwood (1993, p. 306) in their research on meaningful school improvement. Thus the school, rather than the individual classroom, or the state or district, is the focus of this study. Furthermore,
as the instructional and organizational head of the school, the principal is at the crux of the data issue.

School improvement literature often discusses principals and data-based decision making, a term which can become an often repeated mantra in education (Marsh, Pane, & Hamilton, 2006) lacking specificity or real meaning. Defining what is meant by “data” and how research has explored its use for school-wide operational or programmatic improvement will clarify the term data-based decision making for the purposes of this study. This section also reviews the principal data-based decision-making literature. Then, by situating the role of principals in the current educational climate, the review of the literature shows that the external accountability principals face is linked to their internal responsibilities (Knapp & Feldman, 2012), and that data are at the intersection.

**The Impact of a Principal on School Effectiveness**

Preparing for school-wide improvements requires a different lens than for improvement in teaching strategies. There is a wide range of literature that addresses how to undertake instructional data-based changes, or classroom-level initiatives (see for example Boudett, City, & Murnane, 2005). Optimum reform, however, demands not only classroom data-based decision making, but also data-based decision making at the school level (Bernhardt, 2004; Bryk, et al., 2010; Hess & Fullerton, 2013). In particular, high schools are complex organizations with large staffs and multi-faceted programs; data-based high school change is difficult but necessary (Kennedy, et al., 2009). Addressing school-wide operational improvements in all grade levels translates to a focus on the role of the principal, who monitors the functioning of the school as a system, and also leads the School Improvement Team and its program planning.
Management and leadership. Stronge (1993) refuted the view that there is a dichotomy of management versus instructional leadership in the role of the principal, noting that the idea that the latter is more worthy, while “managerial responsibilities are relatively unimportant ... runs contrary to reality” (p. 4). Daily responsibilities—ensuring the safe and effective functioning of the whole school—are vital, and they require data-based decision making on the part of the principal. A study of 314 principals in Miami-Dade County Public Schools (triangulated by data from assistant principals, teachers, and parents) identified key organizational skills in effective principals (Grissom & Loeb, 2011). “Principals devoting significant energy to becoming instructional leaders—in the narrow sense—are unlikely to see school improvement unless they increase their capacity for Organization Management as well” (p. 1119). Similarly, Bryk, et al.’s (2010) study of effective schools in Chicago highlighted the organizational dynamic of a school, and the managerial skills of a principal, without which instructional improvements have little chance of success.

For example, in their study of several hundred elementary schools in Chicago over a seven year period, Bryk, et al. (2010) examined aspects of a school which facilitate instruction. Examining the academic productivity of classroom activity, they articulated two factors which may enhance or diminish the work of the teacher. The first was time devoted to actual instruction. Not only does classroom time management vary considerably from teacher to teacher, but school time management varies widely as well. As evidence, they referred to a study of fifteen Chicago schools in 1994-95 by Smith (1998, cited in Bryk, et al., 2010) which found that out of 180 school days, as few as 125 may be “fully devoted to grade-level, academic work” (p. 263). This loss of instructional time was not under the control of the classroom teacher; principals are gatekeepers for the school schedule. Principals also plan or
evaluate school-wide responses to problems which reduce classroom time, such as absenteeism or tardiness. How much time teachers spend on these problems also impacts instructional effectiveness (Bryk, et al., 2010).

**School-wide academic problem solving.** The second factor impacting instructional productivity according to Bryk, et al. (2010) is “the effectiveness of the supplemental academic and social supports for learning” (p. 49). These are school-wide programs or services which advance or inhibit the efforts of students and teachers. The principal leads the efforts to identify the most urgent problems, to plan and implement the solutions, and finally to determine whether the solutions have ultimately made a difference. In addition to being the instructional leader of the school, principals manage a large number of programs. An evaluative capacity is essential for principals to structure these programs efficiently and to measure their impact.

Routinizing instructional innovations is a difficult albeit essential area of school-wide improvement (Bain, 2007). While one or a few classroom teachers may have successful practices, schools often fail to make these practices influential across the building. In his book about school reform, Bain (2007) pointed to the “organizational capacity” (p. 137) necessary for scaling up classroom practices to an entire school. In a study of eight principals and two district leaders in Israel following the implementation of an information management system in their schools, Blau and Presser (2013) described improved time management leading to increased school effectiveness. Additionally, “the instant flow of up-to-date information between different stakeholders created an atmosphere of transparency and connectedness, improving the school climate” (p. 1008). These issues of organizational skills and school time management enable or constrain effective instruction.
Research has demonstrated that principal leadership is a significant factor in school effectiveness (Fullan, 2001; Hallinger & Heck, 1998; Knapp & Feldman, 2012; Leithwood & Wahlstrom, 2008; Marks & Printy, 2003; Militello, Rallis, & Goldring, 2009) and studies have highlighted the importance of organizational or managerial leadership in particular (Grissom & Loeb, 2011; Hallinger & Snidvongs, 2008; Stronge, 1993). Thus, the principal plays a transformational role in the academic and operational health of the school and also significantly impacts data use across the building. In their review of 15 years of school leadership research, Hallinger and Heck (1998) noted that scholars are moving away from asking whether or not principals make a difference (research has affirmed that they do) to seeking an understanding of how principals make a difference. Understanding how effective principals use the tools at their disposal to make a difference in their schools will lead to improvements in the knowledge, skills, and dispositions of all principals.

**Data Use and School Effectiveness**

Data use permeates every responsibility principals face as leaders of their schools (Knapp & Feldman, 2012). In order to support the work of teachers and run the building, principals must lead with data; therefore Knapp and Feldman concluded that an understanding of how principals make a difference as they lead with data is vital. In the most effective urban schools they studied, Lachat and Smith (2005) noted that “the use of data was strongly influenced by the leadership of the principal” (p. 344).

Indeed, it was Fullan’s (2001) examination of leadership which led to his powerful discussion of moral purpose, change, and relationships. The use of data admittedly requires a certain technological expertise, but far more importantly, effective data-based action requires sustained, accomplished leadership to articulate and convey the moral purpose of the
school’s efforts. In addition, a principal who is highly skilled with the technological or statistical aspects of data but challenged by the relational aspect of leadership is unlikely to bring about change. Bryk, et al. (2010) found evidence that what they called relational trust “conditions a school’s capacity to undertake new reform initiatives” (p. 141). Existing relational trust prepares the terrain for improvement efforts, creates a motivation for the hard work necessary, and allows for deep engagement among school professionals. Describing data-based decision making cannot be fully separated from the concept of leadership as explored by Fullan (2001) or the idea of relational trust studied by Bryk, et al. (2010).

**How do data lead to change?** Copland, Knapp, and Swinnerton (2009) discussed the precise role data and principals play in school improvement, and “in particular, how data enter into change processes” (p. 154). They used the term “data-informed educational leadership” (p. 156) and juxtaposed “informed” with the frequently used terms “data-driven” or “data-based” by explaining the many factors which combine for leaders’ decision making, as opposed to the idea of a change driven solely by data. These authors also point out that data do not prescribe action; rarely do data even point unequivocally to certain conclusions. “Given the inherent ambiguity” (p. 156) of data, Copland et al. (2009) focus heavily on principal leadership. Principals are the change agents who make meaning from data and then take action to improve their schools.

If an innovative tool such as Home Base in North Carolina is to bring data into change processes (Copland, et al., 2009), it is the principal who must ensure that these data dashboards lead to dynamic improvement. Building collaborative teams to examine data, enabling individuals, and connecting data analysis to school improvement are the tasks of an effective principal who understands his role as an organizer and supporter of experts (DuFour
& Eaker, 1998; Earl & Katz, 2006; Leithwood, Aitken, & Jantzi, 2006; Wayman & Cho, 2009). The point to analyzing data patterns would be to craft an intervention to change the future as the data trends currently forecast it. Sharing this vision, implementing that intervention, monitoring the progress; these are the actions that give data power. When writing their manual for leaders in the current age of abundant data and school accountability, Earl and Katz (2006) noted the need “to transform data into information, then into knowledge, and ultimately into constructive action” (p. 2).

**Ensuring data use across the building.** In various ways, scholars have pointed to the essential role of the principal with any school initiative, instructional or organizational. There may be multiple models of excellent principal leadership (Militello & Ersozlu, 2013), nevertheless principals have “visionary, structural, and positional power” (p. 245) and their leadership role is key. Brockmeier, Sermon, and Hope (2005) recounted the history of technology’s promise for education, noting that until scholars began to see that schools could not harness the power of technology unless the principal made it happen, the classroom teacher received initial research attention. Other authors have also pointed to the essential role of the principal as a conduit for current research (Biddle & Saha, 2006; Fullan, 2001; Fusarelli, 2008; Marsh, et al., 2006). Principals lead “knowledge building” in their schools; it should be “a core value [and leaders should] create specific opportunities to engage in the process” (Fullan, 2001, p. 90). Lasting change in schools will not happen without a focus on the school as the unit of knowledge usage and on the principal as the leader of knowledge utilization (Cousins & Leithwood, 1993). The school principal is responsible for establishing the culture of constructive intellectual debate and evidence-based program changes.
instructional or organizational. Principals are indeed the gatekeepers for effective change in the local school, and an essential aspect of their role is ensuring data use.

**Which Data?**

A principal is expected to lead teachers as they use formative and summative assessment data to improve their instruction. The principal must establish a cycle of inquiry (Copland, et al., 2009) or an inquiry habit of mind (Earl & Katz, 2006) or a collaborative inquiry-action cycle (Militello, Rallis, & Goldring, 2009) throughout the school. With this enormous instructional responsibility frequently comes a primary focus on achievement data, often for accountability purposes (Shen, et al., 2012). However, student achievement data are far from the only information at a principal’s disposal (Bernhardt, 2004), and achievement data alone are insufficient even for instructionally-focused decision making (Moss, 2012). To organize the types of data available to schools, and to lead schools away from a less productive, narrow focus on achievement data, Bernhardt (2004) designed a well-rounded series of measures: demographics, perceptions, student learning, and school processes. In Figure 3, Bernhardt’s four categories are shown as interrelated influences on schools.
School processes. The category Bernhardt (2004) calls “school processes” is perhaps the least intuitive; it consists of “scheduling, class size, discipline strategies and results, student groupings, [as well as] policies and procedures,” among other processes (p. 138). Bernhardt’s recommendations for evaluating school processes include studying what she called “flow charts” (p. 143), or what evaluators might call a logic model, because data-based decision making related to school processes requires an understanding of how those processes are designed. According to Bernhardt, examining the theoretical intentions of school processes against the demands of reality is essential for schools trying to understand how they are or are not getting the results they want. In addition, she discussed self-assessments to help the staff monitor progress and to structure the implementation or assessment so that teachers are able to circulate in the school, and “develop a school wide
view of implementation” (p. 143). Finally, Bernhardt underscored the importance of soliciting student perceptions of school processes, which may well differ from staff understanding of the student experience.

**Daily school operations.** Although data collection of student achievement information for accountability purposes in the improvement process may be appropriate for improving teaching and learning specifically, schools must also consider operational issues—a big picture focus of the school as a whole (Hess & Fullerton, 2009). Operational improvement should rely on school process data, as outlined by Bernhardt (2004). Furthermore, Coburn and Turner (2012) point out that conventional data use approaches not only focus narrowly on data use tied to student outcomes, but also focus on the activities of data use via a study of a data intervention in a generic, how-to method, devoid of context. Coburn and Turner argue that effective data use research should be grounded in the interactive nature of data use, the role of the unique professional context, and an understanding of data use as a “situated phenomenon” (p. 103), the complexity of which cannot be easily captured.

It has been established that principal leadership matters in schools, and that their leadership of data use is essential. Further, leaders’ access to and use of comprehensive school data (not limited to student outcomes data) influences the teaching and learning processes. Examining the data necessary for monitoring, enabling, and evaluating instruction comprise the core work of the principal (Bryk, et al., 2010; Copland, et al., 2009; DuFour & Eaker, 1998; Leithwood, et al., 2006; White & Smith, 2010). Notwithstanding this important understanding of data use to improve instruction however, the focus of this study is on data-based decision making for the school as a whole; on decisions which will certainly impact
teaching and learning, albeit less directly. A school’s main action occurs in the classroom, but that action occurs best in the context of a well-organized school. Bryk, et al. (2010) contend that leadership entails the frequently cited responsibilities of the principal (development of staff and oversight of curriculum), but more fundamentally, the principal must ensure a smoothly running school. “Especially in times of change, when innovations are being attempted ... an inability to support effective daily school operations can quickly grind these change processes to a halt” (Bryk, 2010, p. 127). Effectively supporting daily school operations is one of the two data-based purposes highlighted here.

**Planning and evaluating school programs.** The decision-making process is a focus as well as “the effectiveness of the decisions and courses of action taken” (Picciano, 2009, p. 134). Schools are familiar with formative and summative assessment terminology (Militello, Bass, Jackson, & Wang, 2013) and assessing their programming can be viewed through a formative and summative lens as well. Discussing academic accountability, Konold and Kauffman (2009) pointed out that formative evaluation far exceeds the usefulness of yearly measurement “prevention of failure requires anticipating it or at least catching it in its incipient states, not pointing it out long after the fact” (p. 81). The same should be true of school-wide programs which consume staff time and financial resources. Copland, et al. (2009) framed evaluation as a need to “assess progress” (p. 162) in order to determine if the problem chosen for a solution was the right one, and of course whether the solution worked as expected. School leaders can and should move from collecting and managing data to evaluating situations and programs with data. School programming is an important factor in academic success, principals are charged with planning these programs and should be evaluating them as well. Thus, educators must become evaluators.
With the right use of all the information schools collect, data-based decision making is indeed a form of evaluation (Marchant & Paulson, 2009). The research principles (validity, selection of participants, sound statistical analyses), without which decisions or evaluations of decisions are unreliable, present difficulties for educators. Marchant and Paulson concluded more optimistically however, that “recently there has been a convergence of perspectives” (p. 236) between academic researchers and practitioners, noting that it is this partnership in which data-based decision making can better function as evaluation. School professionals must certainly move beyond accountability data toward effective data-based decision making. The message of Marchant and Paulson (2009) is simply that given the potential pitfalls for evaluators without evaluation expertise, educators must proceed with caution.

Hess and Fullerton (2009), referencing the Balanced Scorecard (BSC) of Kaplan and Norton (1992), highlighted the need for operational metrics as well as (student) performance data. While Hess and Fullerton prioritized their discussion of management issues on the level of human resources and financial practices, and less so on local school-wide organizational management, their point is still a valid one. Schools must examine their organizational performance as well as their students’ achievement. Hallinger and Snidvongs (2008), also referencing the Balanced Scorecard, pointed out lessons educators can learn from business management principles. In contrast to Hess and Fullerton (2009), their argument was not so much for the business lessons related to finances or personnel, but for managing information, or what this study calls knowledge utilization (cf. Cousins & Leithwood, 1993). They suggest that the BSC concept enables a move away from a limited focus on student achievement to “a wider range of measurable outcomes” schools could use to determine their effectiveness. The
BSC in the corporate world equates to the potential value that data dashboard technology offers schools. Access to a wider range of data via the dashboard, visually presented effectively, with personnel development leading to the successful use of those data, could transform school improvement efforts by bringing a wide range of measurable outcomes to the fingertips of leaders.

**The Challenges of Empirically Studying Principal Effects**

McLeod and Richardson (2013) cautioned that for schools to be successful with technology integration and implementation, policymakers should invest in the professional development of principals. The principal’s key role in a school’s overall success, as presented earlier in this review, includes the vital work of leading school-wide implementations. Grissom and Loeb (2011) studied principal effectiveness, seeking to identify specific principal skills. They prefaced their research by listing two major obstacles, noting that “data suitable for doing rigorous empirical work in this area are scarce” (p. 1092) and further, that the multifaceted professional context of the principal complicates efforts to link principal behaviors to student outcomes. Authors such as McLeod and Richardson (2013) as well as Grissom and Loeb (2011) have argued that the influence of the principal on a school’s effectiveness merits the investment, but that realistically, it is difficult to accomplish. Grissom and Loeb (2011) further noted that investigations of instructional leadership have, “to some extent, crowded out the study of other aspects of principal work” (p. 1092).

While the overall body of principal research clearly supports that position, researchers have found studying actual principal effects difficult (Hallinger & Heck, 1998; Leithwood & Jantzi, 1999). Articulating the relationship between the school principal and student
achievement presents challenges for scholars seeking empirical evidence of a “significant and measurable contribution” made by the principal (Hallinger & Heck, 1998, p. 158). Studies of any kind specifically designed to measure data use by the principal, and its impact on student achievement, are rare. However, several studies presented in the section following this one manage to provide meaningful evidence of the link between leadership and data use, and the subsequent impact of both on student performance.

The mediated effects models described by Hallinger and Heck (1998) help explain the complexity of principal influence. Reviewing quantitative studies of principal actions related to student outcomes, they concluded that leaders’ impact on student achievement cannot be measured directly, as their influence is achieved through indirect paths. Studies with more sophisticated analytical approaches (mediated-effects models) found a “more consistent pattern of positive indirect effects of principal leadership on school effectiveness” (p. 167). Using the example of a low performing school whose principal begins his or her tenure with very different behaviors (improving organization and discipline) than the leadership behaviors exhibited later when the school is functioning smoothly, Hallinger and Heck further describe leadership as measured through a reciprocal effects model. Leadership is not static, and because changes in the school’s structure cause changes in the demands faced by the principal, a reciprocal process is at work. None of the earlier models reviewed by Hallinger and Heck (1998) were designed to test for reciprocal effects, and the authors noted that improvements in data collection and methodological techniques make this a promising area for future research.

Leithwood and Jantzi (1999) use student engagement with school as the dependent variable in their attempt to provide evidence of principal influence. With a behavioral
component and an affective component (p. 684), this measure was chosen to expand the research base beyond achievement data and because student engagement can reasonably be connected to ultimate academic outcomes. Examining the influence of principal leadership on student engagement, Leithwood and Jantzi found weak but significant positive effects. The more insightful results of their study, however, were found in the explanatory power of the mediating variables, five school conditions, and the moderating effects of family educational culture. The five conditions included purposes and goals, culture, information collection, planning, and structure and organization. Family educational culture was the variable used as a proxy for socioeconomic status. With family educational culture as a moderating variable, and with student engagement as the dependent variable, the authors sought to expand beyond typical measures, and further argued that family educational culture captured more precisely the contributions of home and family influences.

Noting the limited amount of variance in student outcomes actually explained by educational factors for which data were available, Leithwood and Jantzi point out the significant relationship between principal leadership and the five school conditions measured in the study, which explained “a total of 27% of the variance in those conditions” (p. 697). With their evidence of principal leadership on student engagement, mediated by the impact on school conditions, and moderated by family educational culture, Leithwood and Jantzi (1999) were able to provide a much more nuanced view of principal leadership. The review of Hallinger and Heck (1998) as well as the large survey study of Leithwood and Jantzi (1999) demonstrate the research challenge inherent in principal leadership studies. However, they also provide evidence for the significant influence of principals when researchers have the means to overcome the methodological challenges.
Evidence of Principal Data Use Via Leadership Research

Principal leadership is linked to student outcomes in direct and indirect ways. One example of a direct link is leadership of the School Improvement Plan, which, while required in most schools, may not always be effectively designed, implemented, or evaluated. To explore the role of data and evaluative capacity in leadership, a study commissioned by The Wallace Foundation in 2004 conducted a review of leadership research. It included principal, district, and state leadership approaches, and noted the importance of the School Improvement Plan. Principals need to “master [the] skills associated with productive planning and the implementation of such plans” (Leithwood, Louis, Anderson, & Wahlstrom, 2004, p. 12). This mastery includes a strong capacity for the program planning and evaluation necessary for School Improvement Plans. Without this capacity, necessary improvements flounder and student outcomes suffer.

Principal responsibilities which require effective data use. A meta-analysis research study by Marzano, Waters, and McNulty (2005) synthesized 69 studies from 1978-2001 which examined principal leadership. Marzano and his colleagues identified 21 principal responsibilities; for example, knowledge of curriculum, instruction, and assessment; communication; flexibility; and visibility. Data use can be broadly defined to logically play a role in each of the 21 responsibilities, and this list would be a reasonable framework for professional development in preparation for a major disruptive technology such as a data dashboard. However, to highlight several examples—monitoring and evaluating and order—is instructive. In particular, situational awareness, because it is also a key dashboard concept (Few, 2013), merits attention and is described in the section which follows.
Most principals would likely agree without reservation that *monitoring and evaluating* are important responsibilities. However, principals experience unpredictable days, and these responsibilities may not be prioritized. Data dashboards make the *monitoring* of school data an efficient and natural process, for example, consuming far less of a principal’s time than previous means of accessing data. When a principal has dashboard access to school data, *evaluating* can become seamlessly integrated into the day, rather than an additional task to be undertaken when time permits.

As an illustration of what is meant by *order*, Marzano, et al. (2005) noted that this responsibility “is executed when the school leaders establishes and implements a procedure for equitable access to the copy machine” (p. 58). At the risk of attenuating the importance of the many routines, structures, rules, and procedures essential for the efficient functioning of the school (p. 57), the copy machine example serves as a means for relating data use to *order*. A principal without access or ability to use varied data notices that the school paper expenses are exceeding expectations. A general all-staff email warns everyone to reduce copying. Perhaps harsher messages go out if paper consumption is not reduced. Finally, staff access to paper is simply cut off, when the paper allotment or copier budget is exhausted. Instead of promoting this inefficient means of accessing the copier, a data-minded administrator may examine copier use by grade level, location in the school, or time of year. This information may lead to a more equitable solution or practical suggestions, which distract staff less from the core work of teaching. Student learning is impacted by the administrative details encompassed in *order* as illustrated by copy machine access, directly when needed materials are not available, and indirectly when their teachers function inefficiently in the face of inconsistent resources.
Situational awareness and the data dashboard. A third principal responsibility, situational awareness, coincides with a key dashboard concept. This section describes the overlap of principal responsibilities according to education scholars with the capability of a dashboard according to dashboard literature. Situational awareness, according to Marzano, et al. (2005) includes the following characteristics:

- accurately predicting what could go wrong from day to day
- being aware of informal groups and relationships among the staff
- being aware of issues in the school that have not surfaced but could create discord (p. 60)

Data presented to school principals via a dashboard provides a daily understanding of the functioning of the school, visually presenting the data in ways which allow for efficient human processing and the ability to see patterns or trends quickly. In other domains, this may be called predictive analytics (Chen, et al., 2012; Kudyba & Gregorio, 2010). A dashboard is designed precisely for situational awareness (Few, 2013, p. 31). Discussing the limits of working memory, Few (2013) noted that without “limits and filters, what we perceive would overwhelm us” (p. 78). Working memory is “temporary, ... dedicated to visual information , ... [and] has limited capacity” (p. 79). A dashboard packages information visually in efficient ways to afford optimal processing of information. For successful situational awareness, principals need access to well designed data dashboards.

Principal Data Use Directly Examined: Empirical Evidence

A synthesis of five principal studies will provide evidence related to direct data use. Three of these studies set out to directly examine principal perspectives of data use (Militello, et al., 2013; Shen, et al., 2012) or evidence-based practice by educators, including principals (Coburn & Talbert, 2006). A fourth study originated from a desire to understand
successful schools in difficult districts, and resulted in findings concerning first, effective principal use of data technology provided through accountability requirements and second, the large role of data-based decision making in those schools (Knapp & Feldman, 2012). The final study investigated the use of information for school improvement, with results indicating that characteristics of the setting and factors related to the information itself both had effects on information use (Cousins & Leithwood, 1993). As has been true throughout this literature review, terminology varies greatly. Several studies used the word “data” or the phrase “data-based decision making” (Militello, et al., 2013; Knapp & Feldman, 2012; Shen, et al., 2012), one used the term “evidence” or “evidence-based practice” (Coburn & Talbert, 2006) and another referred to “knowledge” and “knowledge utilization” (Cousins & Leithwood, 1993). Regardless, all sought to understand the potential for improving practice in education.

**Which data?** As discussed earlier in this review, an immediate question arising in these studies is about what kind of data, exactly, are being studied. Militello, et al., (2013) found that educators (principals and teachers) reported using data to inform their practice. However, they noted that their findings suggest future research about how to define data, which in this study was “left to the interpretation of the respondent” (p. 112). As for principals, the authors noted that principals were in agreement that they “collect, analyze, and use school data to evaluate school programs” (p. 108). Although in their literature review, Militello, et al. (2013) largely explored assessment data use in education, their findings regarding principal use of data for school improvement again suggest future research needed to explore the use of data to evaluate school programs as a less understood aspect of data use.
In their interviews of 16 Michigan principals, Shen, et al., (2012) asked what data principals have, what data they use, and how it informs their decision making. “All 16 principals mentioned the usage of student achievement data, but only two principals indicated the usage of student and community background data and three principals mentioned school process data” (p. 442). By school process data, the principals were primarily referring to attendance and discipline data. Shen, et al. noted that monitoring and evaluating school programs was not mentioned at all, nor was the use of data to supervise instructional practices (such as classroom observation data). These authors make three points about their findings, first noting the conflict of “data for accountability versus data for learning” (p. 444) given the overwhelming use of achievement data (and limited use of any other kind of data). Secondly, they argue that important data sources are untapped by principals, and finally, referring to Bernhardt (2004), they conclude that important data insights are unavailable to principals who do not make use of “various streams of data ... [because] the meaning of the achievement data is very limited, especially for the purpose of informing decisions that school leaders and their staffs make to improve the school outcomes” (p. 444).

**Data as evidence.** Coburn and Talbert (2006) asked educators in a variety of roles to explain what, in their opinion, constituted sufficient evidence to support taking action. Asking specifically about student learning and research findings, these authors found considerable difference among educators, but also identified patterns of their understanding based on their work roles. School-based staffs were far less often focused on the psychometric properties of tests and expressed more skepticism about the value of research to inform decision making than did top-level district administrators. However, Coburn and
Talbert (2006) note that principals, more than either teachers or district administrators, “pointed to the need for multiple measures as a criterion for valid evidence; more than 80 percent of principals expressed this view” (p. 485). As an explanation, the authors pointed to the professional demands placed on principals who are responsible for the school as a whole, including the development of the School Improvement Plan.

Cousins and Leithwood (1993), in another study seeking to understand what information becomes influential in a school, identified several aspects about the information itself and characteristics of the setting which influence the utilization of information, or knowledge. Surveying 233 school principals and 155 district administrators, Cousins and Leithwood found that the perceived sophistication, relevance, timeliness, and content of the information, as well as the needs of the user and the user’s receptiveness, explained from 22% to 30% of the variation in the individuals’ reporting of information use. While these findings help define the words “data use” (What kinds of data get used? How does the user’s context matter?), the authors were careful to note that their quantitative results do not account for interaction effects among these factors.

Principals (as well as other educators) may associate the word data with a narrow view of student achievement data (Shen, et al., 2012) either because they do not in fact use data of other kinds, or because they do not perceive evidence about programs or observational information to be “data”. To tease out the kinds of data principals are referring to can be a challenge (Militello, et al., 2013). The factors which can be clarified from a user’s perception may interact, further obscuring a path to straightforward understanding of data use (Cousins & Leithwood, 1993). The final study to be described here unexpectedly focused on data use, as they set about attempting to capture “what was taking place at [the]
intersections” (Knapp & Feldman, 2012, p. 677) between internal and external accountability.

Studying exemplar schools in four struggling urban districts, Knapp and Feldman (2012) repeatedly interviewed leaders and others in these schools across a period of a year and a half. In addition, researchers observed leaders in action as well as instruction in order to fully comprehend the climate of the school. They began their work with the concept of leadership, and “accountability emerged as a central and unmistakable theme across study sites” (p. 679). The school’s reaction to externally placed demands (for accountability, for the use of specific resources) depended on the quality of the internal school structure, in terms of culture or professional work. Knapp and Feldman identified the principal as the link between the external and the internal accountability. In terms of data use per se, Knapp and Feldman (2012) emphasized that “data were a constant accompaniment to leadership work, and a medium for conversation about instructional improvement” (p. 683). In addition to the “ever-present” achievement data, they noted that the variety of data in use in these schools was “striking” (p. 683). A principal's leadership can be viewed through this link between external and internal accountability.

How External Accountability Impacts Principal Data Use

The No Child Left Behind (NCLB) Act of 2001 has intensified data collection in American schools. The demand for accountability has fueled development of data technology because accountability requires frequent measurement of student outcomes; thus data accumulates. However, the demand for accountability has the potential to actually hinder school improvement (Copland, et al., 2009; Konold & Kauffman, 2009; Marzano, 2009). Absent effective decision-making skills, the increased data collection, storage, and retrieval
can consume leaders to the exclusion of analysis. For schools without the necessary internal structure and local processes, decision making will falter, missing what Guerra-López and Toker (2012) called the link between school “report cards ... [and] the various school improvement initiatives, enroute results, and ultimate outcomes” (p. 222). Schools need internal procedures to arrive at the externally required destination.

Some scholars portray NCLB as a possible drain on data-based decision making possibilities (Copland, et al., 2009; Guerra-López & Toker, 2012; Konold & Kauffman, 2009; Marzano, 2009) and others warn of political issues and convictions surrounding federal initiatives which may interfere with a school’s work (Kowalski, 2009). However, ultimately accountability demands also have the potential to improve school processes (Coburn & Talbert, 2006; Knapp & Feldman, 2012; Wayman, et al., 2013). In this way, schools can move from “accountability as surveillance to accountability for improvement” (Earl and Katz, 2006, p. 17).

School leaders have retooled many of their decision-making processes as NCLB required new accountability measures (Petersen & Dlugosh, 2009). Laws such as NCLB, however, are more of a driver and less of a guide. (Wayman, et al., 2013). While emphasizing that NCLB does not inhibit good data use, Wayman, et al., point out factors associated with NCLB which are not helpful for effective data-based decision making in schools. The local processes of using data to inform instruction and decision making are left to the schools, and educators’ capacity to use the required data effectively “are often lacking or absent” (Wayman, et al., 2013, p. 144). State achievement test performance “may be salient at the district level [but] not salient at the school or classroom level” (Wayman, et al.,
2013, p. 141). A focus on assessments for accountability can crowd out other data (Shen, et al., 2012).

The challenge therefore, is for schools to profit from the “pressures and incentives” of NCLB in order “to use evidence of student learning to assess their policies and practices and to adopt improvement strategies rooted in research” (Coburn & Talbert, p. 490). It is the principal, according to Knapp and Feldman (2012), who has the responsibility to translate external demands into internal structure and staff expectations. The external demands such as NCLB force attention to data resources (Wayman, Spikes, & Volonnino, 2013). The new responsibilities of the principal (increasing external demands) and the new tools (data technology) have redefined the principal role. Principals successful with school improvement accomplish more than basic compliance with external accountability demands. Neither do these successful principals allow external accountability to distract the school from the core work of educating students.

This “intersection of internal and external accountability” (Knapp and Feldman, 2012, p. 670) is where the principal profits from the opportunities and resources which exist as a result of a state’s efforts to comply with federal requirements or incentives. In North Carolina, for example, the technology projects which include Home Base are happening because of a federal focus on data, as embodied by the Race to the Top incentive grants. The question becomes how to ensure that school principals, in North Carolina and elsewhere, “are in a good position to engage the external environment and all its demands as a resource for the learning improvement work of the school” (Knapp & Feldman, 2012, p. 675).
Dashboard Technology

Having situated the principal as a key player and gatekeeper for data use and school improvement, this review now explores dashboard design, data technology's impact in domains other than education, and concludes with a brief overview of education technology. The data use literature notes that principals may be skeptical about the value of data technology and wary of increased data access. Research describes the disconnect between access and use when discussing the research-use gap (Hemsley-Brown, 2009); describing the effect of drowning in data (Brown & Duguid, 2000; Roderick, 2012); pointing out the difficulty of finding timely access to accurate information (Lachat & Smith, 2005); noting the lack of common understanding of what constitutes data (Militello, et al., 2013); identifying problems which occur in the absence of a system-wide data initiative (Wayman, et al., 2013); and explaining the need for more role-based data literacy training (Mandinach & Gummer, 2013).

Principals wary of increased data not only need tools to access and manage school data, they likely also need to persuasion as to the benefits of data. In order to combat the skepticism of potential users, it is useful to examine an innovative educational data management system in light of research on how data are known to enable decision making. How the data are presented to users makes an enormous difference in their reactions and potential for effective use. The power of a dashboard interface resides in “a growing recognition of visual perception as a powerful channel for information acquisition and comprehension” (Few, 2006, p. 37). As well as lessons available in the business literature about strategic data use, the nascent field of data visualization offers guidance as to how data dashboards might best function to facilitate data access and data-based decision making.
A Case for Data Visualization, or Visual Analytics

The problem, therefore, is not a need for more data. On the contrary, the risk is that the “famine has quickly turned to glut” and a deluge of information threatens to paralyze users (Brown & Duguid, 2000, p. 12). Data visualization is a field which offers solutions to users who want to make better sense of their information. According to a governmental entity set up to coordinate this developing field, “visual analytics tools and techniques will become the 21st century’s answer to information overload” (“National Visualization and Analytics Center, Marketing Brief”, 2009). The New Media Consortium, an “international community of experts in educational technology”, promotes an understanding of emerging technologies and their anticipated impact in education contexts (“About the NMC”, n.d.). In the New Media Consortium’s Horizon Report (2010) Johnson, Levine, Smith, and Stone discussed visual data analysis:

The new field of visual data analysis ... is not only characterized by its focus on making use of the pattern matching skills that seem to be hard-wired into the human brain, but also in the way in which it facilitates the work of teams working in concert to tease out meaning from complex sets of information. (p. 29)

Visual analytics thus offers an understanding of how humans process the information they perceive through an interface. States which ignore the contributions of data visualization decrease the potential effectiveness of data technology, and may not maximize the investment they have made into an expensive data system purchased for their schools (Wayman & Cho, 2009).

The potential of a dashboard to corral the information overload comes when data organization and management techniques are designed into the dashboard, and when the
The dashboard has the ability to spur the human interpretations and reactions which turn information into knowledge (Petrides & Nodine, 2003; Velcu-Laitinen & Yigitbasioglu, 2012). These visual representations are interactive and serve to improve human cognition and interpretation. The best ones “blend highly advanced computational methods with sophisticated graphics engines to tap the extraordinary ability of humans to see patterns and structure in even the most complex visual presentations” (Johnson, et al., 2010). The visual representation of the information reduces the gap between the complex technologies using massive amounts of data and the humans who are expected to make decisions based on that data (Huang, Liu, & Chang, 2012; Scholtz, Cook, Whiting, Lemon, & Greenblatt, 2009).

Technology facilitates the human interpretation of data, human use of data, and social interaction around data. Data tools “play a supporting role in the essentially human and social effort of making meaning out of experience” (Bienkowski, et al., 2012 p. 41). To understand this process of making meaning requires an examination not only of the technology interface, but the experience of the user who interacts with, and potentially even alters, the technology (Carroll & Campbell, 1989). This study proposes to develop theory about the use of the technology interface, or the dashboard. An outcome of the study will likely be identification of key dashboard design features; a quasi design evaluation as part of the theory development (Carroll, Singley, & Rosson, 1992).

What is a Data Dashboard?

In 2003, an article in Computerworld (Leon) announced the new democracy of information systems. With key data at their fingertips, frontline workers are empowered to make smarter and faster day-to-day decisions. The tool facilitating this groundbreaking access is called a dashboard, and it is designed to coordinate information from multiple
sources in a user-friendly fashion, like the dashboard of a car. A dashboard is a platform which not only integrates access to several programs, but also organizes and prioritizes the presentation of the data. According to information technology author and consultant Stephen Few, “a dashboard is a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance” (Few, 2004, p. 3). Decision-makers at one time requested a report, printed spreadsheets, or summoned financial results and then pored over the rows and columns seeking insight. With the more practical and less complicated interface of a dashboard, and new developments with data presentation, businesses (and schools) can streamline employee data access and keep the energy and focus of their workers (or educators) on the necessary action steps.

In Education Week in 2006, Honawar described Philadelphia student information provided via a dashboard to teachers, where attendance data as well as academic data intended for classroom-level improvements were readily available. Their dashboard facilitated access to student-level information for the frontline workers, the teachers; the ones who made the daily decisions about instruction. Nearly ten years after Leon’s announcement concerning the democratization of data in the business world, another article in Computerworld (Hildreth, 2012) described the Minnesota Department of Education’s efforts to replace complicated reports with a dashboard. Not only are the data more accessible by more people, but information which had been isolated in one department of the organization, or even on individual desktops, is also standardized and consolidated. Like many dashboards, the system allows its users to drill down to specifics, looking first at district or school data
before seeing a breakdown of information for smaller segments of the school, including the individual student level.

**Dashboard Design**

Eckerson (2005), in a business-oriented dashboard text, noted that corporations need an “organizational magnifying glass” (p. 26). He argued that a dashboard is actually a management tool which takes overall objectives and translates them to metrics and tasks tailored to individual entities within the larger organization. His short list of problematic dashboard designs included those that are too flat, too manual, or too isolated (p. 28). Adapting Eckerson’s descriptions to an education context would mean that a good dashboard has to have access to enough data and analytical capabilities in order for a principal to see the subgroups of the school, for example. The principal needs drill-down capacity to answer questions about the numbers he sees on the dashboard, otherwise the display is too flat.

Eckerson’s (2005) critical look at dashboards also includes pointing out the need for automated updating features. If too much time is required to manually collect and organize the information, the dashboard solution is not sustainable. Finally, the view of the school must be a holistic one, and the metrics should align with the objectives of the district; otherwise it would be too isolated.

The elements of dashboard use are on two levels: the look and feel of the interface should follow certain basic design principles, and leaders must recognize that the indicators which an organization selects to appear on the dashboard will drive the data analysis and understanding (Eckerson, 2005). The first, dashboard design, is under review here, and the second, a discussion of key performance indicators, appears as an organization prepares the
interaction between its human workers and the technology designed to serve them. The science of choosing the metrics, or the key performance indicators, are discussed below.

Few (2004, 2006, 2013) has become a leading dashboard consultant, warning frequently of the dangers of poor design. Founder of a company to “help organizations ... learn to design simple information displays for effective analysis and communication” (“Perceptual Edge”, n.d.), Few has described the many obstacles to useful visual presentation of data. For example, Chapter 2 of his 2013 book about dashboard design lists “thirteen common mistakes in dashboard design” (pp. 35-58), including “exceeding the boundaries of a single screen” (p. 35), “displaying excessive detail or precision” (p. 40), and “highlighting important information ineffectively or not at all” (p. 53).

An intriguing counterpoint to this design discussion is the “intrinsic motivation” label in Huang, et al.’s (2012, p. 261) investigation of the gap between humans and their technology tools. In their study, the authors hypothesized that what they called “computer playfulness” is an intrinsic motivator for users, and that “users with a playful attitude experience more joy when using a DMT [data mining tool] than those without playfulness” (p. 262). They further studied the impact of computer-related anxiety on the technology transition. While Huang, et al. discussed the attitude of the user rather than the playfulness of the tool, nonetheless, their research introduces an intriguing aspect to dashboard design. Could a dashboard appeal in motivating ways to ease anxiety and increase motivation? To further aid schools and technology planners, this study aims to highlight the aspects of dashboards which have the potential to help or hinder school practitioners.
Key Performance Indicators

Technology facilitates data access but humans decide how the dashboards should look, and what data should be prioritized. Who chooses the indicators which will appear? How does an organization’s strategy flow through them? The intuition and analysis prompted by the dashboard should be guided by the indicators which are selected to appear. Allio (2012) listed three issues with performance indicators on dashboards (p. 25). First, indicators not aligned with organization strategy or containing data which are not timely or correct will hobble any dashboard. Second, an overwhelming number of indicators can paralyze decision makers; here, Allio noted the intersection of visual design challenges with the problem of too much volume. Finally, without collaboration, indicators (and the inevitable performance targets) are both poorly understood and poorly implemented. Remote supervisors or external consultants who fail to involve the day-to-day practitioners when setting goals or determining indicators will doom the dashboards to ineffectiveness.

If “a truly strategic dashboard can be catalytic” (Allio, 2012, p. 25), then state planners need to understand the nature of their school dashboards and exactly how they can be a strategic tool for principals. Dashboard authors have noted that leaders must begin with articulating their strategy (Allio, 2012; Few, 2013; Galloway, 2010; Kaplan & Norton, 1992; Power, 2010; Roderick, 2012; Velcu-Laitinen & Yigitbasioglu, 2012). In a study about constructing meaning from information, Choo (1993) noted that “the immediate goal of sensemaking is ... to share a common understanding of what the organization is and what it is doing” (p. 330). Further, to innovate, Choo argued, “the key ... is in unlocking the personal, tacit knowledge of the organization’s members ... [and] this knowledge conversion process” can only happen within the context of that shared understanding of the organization’s goals.
and overarching strategies (p. 338). For schools to improve; that is, for concrete progress in
the classrooms as well as in the buildings which house them, dashboards will need to
function as a smoothly functioning technology based on strategy articulated by human
leaders. This research intends to elicit how successful principals leverage their dashboards in
order to make that concrete progress for school improvement.

**Balanced Scorecards Make Dashboards Worthwhile**

In 1992 a milestone article appeared in the *Harvard Business Review* which
introduced the balanced scorecard as a means for planning toward achievement of key
organizational goals (Kaplan & Norton). It established a forward-looking mindset in response
to business leaders who looked primarily at financial data and rarely at more comprehensive
measures. Since 1992 the balanced scorecard has become a conceptual framework for
corporate strategy (Kaplan, 2012). Schools which see their achievement data as the only
important metric are analogous to the businesses referenced by Kaplan and Norton in 1992,
who based their decision-making on past financial measures rather than by anticipating future
challenges. A school’s comprehensive measures, for example, would likely include student
attendance and discipline data as well as teacher professional development and staff turnover
data. Other examples of data sources (beyond student achievement) are Bernhardt’s (2004)
four measures: demographics, perceptions, student learning, and school processes.

Researchers in education do not discount the central importance of achievement data
(like the profit and loss reports in business); however they have recommended a more
systemic approach to data collection and analysis (Bernhardt, 2004; Hess & Fullerton, 2009;
Konold & Kauffman, 2009; Wayman, et al., 2013). With a dashboard to facilitate a wider
range of data access, schools are being given the tools to manage their organizations more
strategically. Influential statistician W. Edwards Deming advocated for a focus on process over outcomes, maintaining that a leader does not run a business effectively by looking in the rearview mirror (Gabor, 1992). Schools who seek quality in their processes (managing the school through monitoring and analyzing multiple data sources) are, like the corporations in the literature, establishing mechanisms to achieve the outcomes they seek (Gabor, 1992; Kaplan & Norton, 1992). Applying the management benefits of the balanced scorecard to education can achieve the operational improvements which are essential for instructional success (Bryk, et al, 2012; Bain, 2007; Hess & Fullerton, 2009). Dashboards can become an essential tool in the efforts for quality in processes, or organizational improvements.

The work of Kaplan and Norton in the years following the 1992 article has been to teach “strategy execution” to companies using the balanced scorecard (Kaplan, 2012, p. 540). Kaplan noted that he teaches executives to develop a scorecard based on a specific company strategy, coaching them to avoid “wanting what they can measure rather than measuring what they want” (p. 543). Schools too must establish strategic plans to meet their goals, rather than collecting data without direction. Galloway (2010) explicitly articulated the connection between the computer interface, or the data dashboard, and the strategic plan of the organization, or the balanced scorecard. He defined the balanced scorecard as a “system used for management and planning” (p. 39), but also warned of the gap between a scorecard and a dashboard, which is “a computer interface designed to receive and manipulate data from ... various departments” (p. 38) Kaplan’s position 20 years after the breakthrough introduction of the balanced scorecard is that while the “original article’s focus was on performance measurement, ... the BSC [balanced scorecard] could become the foundation of an entirely new system for strategy management and execution” (p. 539).
Schools are often directed to learn from effective business practices. In addition to personnel evaluation or expertise in finances, school leaders should study the knowledge management of business leaders (Hallinger & Snidvongs, 2008). The technology of dashboards has long been a staple in many corporate workplaces; as with successful business leaders, schools adopting them should consider them as a tool for knowledge management. Instead of a software access tool, the dashboard needs to enable strategic management. School principals, in order to strategically manage their organization, need access to data. What’s more, however, these leaders need the data presented in such a way as to lead to knowledge utilization (Cousins & Leithwood, 1993). The nature of the interaction of school leaders with their data is directly determined by the data they or district leaders decide to prioritize, and then how it is presented. The type of use and the possible success will all depend on those choices and the presentation of the data. For a dashboard to be “a balanced scorecard” (Kaplan & Norton, 1992), strategic planning must come first. Only then could a dashboard become “the driving force in an organization” (Galloway, 2010, p. 40), and in education, only then could principals apply the insights gained to the difficult decisions they must make to improve their schools.

The next section summarizes the dashboard literature via the categories of the inputs of the logic models presented in the findings and discussion. The dashboard literature is modeled in terms of the people who use the product to access their data in the context of the organization. Following this section, the literature review continues with a brief review of technology development in the education market.
Model of Dashboard Literature

The dashboard as a tool can enable decision making in powerful ways in any domain. However, K-12 education as a domain has entered the data technology scene more recently than the business world, with its more robust history of information systems and data dashboards. Modeling the dashboard business literature as a whole sheds light on the product itself (as well as the interaction of people and product), the data to which the product provides access, and the organization surrounding these interactions. The text which follows Figure 4 below explains the how the interactions result in the interaction on the right.

People. Analytics, or the reasoning which occurs in the presence of data, is largely a human activity (Chen, et al., 2012; Kudyba & Gregorio, 2010). The user constructs meaning from information; the knowledge, skills, and dispositions of the user will matter enormously. The research literature also treats human-computer interaction as way to improve design (Carroll & Campbell, 1989; Carroll, et al., 1992) even if, as the authors point out, research often highlights issues "only after they have already been codified in a running system" (Carroll & Campbell, 1989, p. 4). Awareness of human computer interaction as design science (p. 7) can contribute to improved results over time as people access technology for information. The knowledge, skills, and dispositions of people and the concomitant impact on decision making, in addition to the psychology of the interaction, center on the dashboard and thus link the product and the people to the decision making. Dashboards as a product are therefore inextricably linked to the people using them, the volume and quality of data available, and the organization's strategies and goals.
Product. The best dashboards represent strategy and carefully calibrated metrics and tasks. Design of the interface itself plays an important role, however. For example, Few (2004, 2006, 2013), dashboard consultant, consistently recommends eliminating clutter and unnecessary graphics or color. Unfortunately, Few has noted repeatedly, dazzling graphics and bright designs often make for appealing marketing tools for potential users uninformed about dashboard effectiveness. An effective dashboard design allows the people using the product to access a greater amount of data without becoming overwhelmed. Therefore, the people using the product have mental space and energy to ask questions of the data and to problem solve, outcomes which leads to the impact of improved decision making. Dashboard design is linked in this way to improved decision making.
**Data.** Research notes the effect of drowning in data (Brown & Duguid, 2000; Roderick, 2012) when users are paralyzed by overwhelming amounts of complex information. Data technology offers visualization as a means for assimilating that complex information, and for the decision making which leads to action (Bienkowski, et al., 2012; Choo, 1993; Huang, et al., 2011; Johnson, et al., 2010; Scholtz, et al., 2009). Data visualization requires "computational methods" in the software to be blended with "sophisticated graphics" (Johnson, et al., 2010) in ways geared to trigger human insights which turn information into knowledge and then action (Petrides & Nodine, 2003; Velcu-Laitinen & Yigitbasioglu, 2012). Consideration of data visualization concepts in the design or purchase of technology increase the potential for the dashboard not only to contain the information overload but also to leverage the technology as a true data access and analytics tool. Data is linked via visualization to the product and to improved decision making.

**Organization.** Eckerson's (2005) descriptions of the dashboard as a management tool point to the necessary alignment between the metrics on the dashboard and the goals or objectives of the organization. An organization (whether a software company or a school district) must therefore not only articulate its standards, or KPIs, and overarching strategy, it must align those KPIs and strategy with the dashboard metrics. Important research in the domain of KPIs and strategy came from Kaplan & Norton in 1992, with their balanced scorecard for business leaders. Without organizational strategy, a dashboard becomes an end rather than a means to an end. Use of a dashboard as an effective tool occurs in an organization which can articulate its overall vision and strategy. An organization's metrics and strategy are linked in this way to improved decision making via the dashboard.
Technology Development in the Education Market

In a recent briefing on education technology (“Catching On At Last,” 2013), The Economist reviewed the status of innovations in schools, noting first the exponentially increasing capacity of information systems to collect and analyze large amounts of data combined with the reporting requirements coming from the federal government. The 2001 No Child Left Behind Act drove schools to improve student achievement measures and reporting, and the Race to the Top grants have prioritized data infrastructure (“ED.gov,” n.d.). Naturally, companies whose products facilitate this data collection and analysis have responded with investments; Pearson PLC, for example, already a sizeable competitor in the education services field, is reported in The Economist to have spent more than “$9 billion in the past decade on technological upgrades for its education business” (“Catching On At Last,” 2013). Writing for the Brookings Institution in 2012, West discussed big data in the education context, explaining that these information management systems organize data which are already being collected in schools. Schools have for some time accumulated enormous amounts of data, but providing appropriate access for key personnel has only recently become feasible. The student information systems currently available can integrate that data “into a simple user interface, and graphically display trends in an easy-to-analyze manner” (West, 2012, p. 8).

Who are the companies in this market? The North Carolina DPI selected Pearson PLC to provide the student information system (SIS) component (called PowerSchool) as well as the assessment component and the dashboard interface of Home Base. Partnering with Pearson to provide the educator evaluation and professional development systems are Public Consulting Group and Truenorthlogic (Price, 2012). Other companies with similar
products include North Carolina-based SAS, with its Enterprise Intelligence Suite for Education (“SAS Resources,” 2013). Oracle also offers a variety of information management applications it markets to schools (“Strengthening Education,” 2006).

**Technology in Education: Purposes and Pitfalls**

Also in this market, companies offer products for instructional support, online education, and adaptive learning, or learning analytics. Major textbook publishers are reconsidering the venue for their content, according to an *Education Week* article (Davis, 2013). Davis described the big three, Pearson, McGraw-Hill, and Houghton Mifflin Harcourt, which are creating a new landscape for education technology, where digital possibilities are driving changes instead of simply supporting traditional instructional methods. Further complicating the education technology terrain, many smaller companies, competing with difficulty in the complicated school market (“Catching On at Last”, 2013), are being acquired by larger companies. North Carolina’s SchoolNet, one of the product options in Home Base, is an example of this type of acquisition. The SchoolNet instructional resource and assessment tool was purchased in 2011 by Pearson, North Carolina’s main vendor for Home Base.

Learning analytics refers to the use of data for systematic feedback to students and subsequent targeted remediation or enrichment, giving schools an opportunity to understand learning in more detailed and nuanced ways (West, 2012). Increasingly frequent use of online textbooks or learning modules, for example, facilitates the collection of information about student learning activities, such as how long students spend on a particular page or unit, how often and at what points they consult glossaries or other helps, or the pathways of common errors. Examining this information in the aggregate (big data) and then modeling it
establishes patterns and trends to inform teaching practices (Bienkowski, et al., 2012). Data for accountability and for the improvement of individual student learning are two large domains in the field of analytics in education. These two domains are related tangentially to the central focus of this study, which is the use of aggregated data and visual presentation (via an integrated dashboard) to improve decision making practices at the school level. The technology market is a multi-faceted and rapidly evolving one, as companies race to adapt their products to the various needs of their consumers, the schools.

Several disadvantages loom large over the burgeoning educational technology market. The accumulation and coordination of massive amounts of student data threatens individual privacy. Reporting on education data for *InformationWeek*, Booker (2013) interviewed critics who “are skeptical about the stated goals of educational data collection per se, which proponents claim is entirely around improving student performance through technology” (Booker, 2013, p. 1). In the Brookings report (2012) West identified the need to balance student privacy with access to data as well. Educause, a nonprofit entity dedicated to information technology in higher education, discussed the downsides to big data in education. Privacy concerns topped the list, but so did the danger of profiling students, or categorizing individual students based on the overall data trends (“7 Things,” 2010).

To appropriately evaluate education technology needs and the products being marketed to schools, research is needed in two areas. First, few evaluations exist which study the impact of large data management systems. In 1990, Wright described a model for selecting information management systems, offering recommendations to schools poised to make these large purchases. In 1999, Vecchioli provided guidance for evaluating record-keeping software, also for the purpose of considering the options in the marketplace prior to a
system purchase. Research provides little empirical information about the comparative value provided by the various products available to schools today. In addition, the field of visual analytics is young, and when vendors are tempted to pull together several products and call the collection a dashboard, consumers may not be capable of evaluating appropriately. Frequently products are sold which have more bells and whistles than actual utility (Few, 2013). In an article describing the technology transition process, Scholtz, et al. (2009) recommended evaluation of the tools on the market, but also described the difficulties inherent in measuring their value. While this study will not result in a measurement of impact, it will further the understanding of visual analytics in education and inform stakeholders about technology developments, preparing them to more critically evaluate the technology products on the market.

**Qualitative Research to Describe and Explore**

The technology landscape is changing for schools. How that landscape will look in a few years is unknown. The technology tools are new and uncommon, and the process of transition just beginning. The research approach, therefore, calls for discovery. “Qualitative research frequently falls within the context of discovery rather than verification” (Ambert, Adler, P.A., Adler, P., & Detzner, 1995, p. 880). The timing of the study proposed here places it at the edge of a large-scale, as yet poorly understood, transformative change, and qualitative research will, appropriately, describe and explore it.

In an applied setting such as the context of this study, decision makers who are orchestrating a large-scale implementation and overseeing the professional development necessary will want to ascertain the training needs. These planners will ask pointed questions, wanting to know not only about the factors key to the use of dashboards, but also
the estimated existence of those factors in the workforce. Given the enormity of the technology changes, and the variety of situations (all public schools across the state), these questions cannot be answered without an appreciation of the nuances of the context. To skip directly to surveys of new users, or even more directly to professional development planning itself without a full understanding of the complexities of an implementation such as Home Base would be foolhardy indeed. Guba and Lincoln (1994) warned of the propensity of quantitative methods to strip context from the findings. For the North Carolina Home Base project, context is paramount and the qualitative approach of this study sets the stage for future quantitative research.

This literature review now situates the research within the domain of program evaluation, defining a theory of change and the effectiveness of a visual diagram, or logic model, to illustrate how a theory of change explains the workings of a program.

**Theory of Change**

Henry and Mark (2003) describe program theory as *small-t* theory which makes explicit program goals as well as the cause-and-effect sequences meant to achieve them (p. 296). This theory is commonly referred to as program theory or theory of change in the domain of program evaluation. Program theory is often articulated via a visual schematic, or a logic model. Rossi, Lipsey, and Freeman (2004) organize the broad concept of program evaluation into five categories: needs assessment, assessment of program theory, assessment of program process, impact assessment, and efficiency assessment. Figure 5 outlines the relationship of program theory with other aspects of evaluation which can occur throughout the life of a program.
Other researchers (e.g. Rogers, 2007; Weiss, 1997a, Weiss, 1997b) call the second category from Figure 5 theory-based evaluation, or TBE; a theory which outlines the stakeholder assumptions regarding the expected effects of a program, then expresses those assumptions (the program’s theory) visually. Weiss (1995) described TBE as an evaluation based on the theory of change. Brousselle and Champagne (2010) approach the evaluation of program theory with a logic analysis framework as a way of elucidating a program’s strengths and weaknesses, then analyzing the logic of the program meant to intervene and produce the desired results. In this study, the term theory of change rather than synonymous expressions is intentionally used because it is thought that to practitioners and planners, this term will connote the meaning of the study most readily. The words suggest an understanding of how change happens or is expected to happen.
Why Theory of Change?

Approaching the study of dashboard use in schools through the lens of program theory is important for several reasons which are explained in this section. Future evaluations of data dashboard technology will benefit. The theory of change underlying data use in particular needs a more developed understanding. A carefully calibrated evaluation of program theory offered now could inform the ongoing implementation of the North Carolina Home Base project, providing “information for decision-making and improving programs” (Henry & Mark, 2003, p. 294). Before justifying the choice of theory of change as a program evaluation approach most appropriate for this research, it is important to review the evaluability assessment process. Evaluability assessment encompasses the type of program theory exploration being discussed here; understanding it allows for an understanding of the timing of different evaluation stages.

Preparing for future evaluations. An evaluability assessment is “a process for clarifying program designs [and] exploring program reality” (Whooley, 2004, p. 35). It is undertaken prior to attempts to measure program effects, and establishes the baselines necessary for effective and efficient evaluations. One of the products of an evaluability assessment is a logic model, with an emphasis on connecting program activities with intermediate outcomes, as a way of understanding the chain of expected events leading to the ultimate impact which is sought (Whooley, 2004).

The focus of the study proposed here is limited to an examination of the theory of change and the creation of a logic model specific to the principal decision-making process as facilitated by a dashboard. This approach, as a subset of an evaluability assessment, is intended to result in a better understanding of the program design and expectations (with the
“program” delimited to dashboard use in the principal context). In a full-scale evaluability assessment, a researcher would continue by recommending changes in program design (this step can be considered an implementation evaluation), developing evaluation options, setting evaluation priorities, and establishing data sources to measure performance (Whooley, 2004, p. 36). Figure 6 shows the key steps of an evaluability assessment and emphasizes the limits of the current study. This study will articulate how dashboards and information systems are expected to trigger change in the decision-making processes of principals, as well as visually present the mechanisms of dashboard use specifically connected to principal decision making. Although what is proposed here is not a complete evaluability assessment, it will offer stakeholders preparation for their future evaluation decisions. In that sense this study functions as a delimited version of an evaluability assessment.

**Developing program theory for data use research.** Our understanding of how data use informs decision making remains underdeveloped (Coburn & Talbert, 2006; Coburn &
Turner, 2012; Moss, 2012; Roderick, 2012; Shen, et al., 2012) and principals would benefit from increased understanding of data use in their schools (Militello, et al., 2013). To improve the decision-making process requires illumination of the change processes. Without that understanding, data interventions (such as sophisticated data technology) may or may not improve decision making, and researchers will not understand how to replicate or change the tools (Coburn & Turner, 2012). This understanding is termed by Coburn and Talbert (2006) as a study of “the practice of data use” which occurs when researchers “seek to understand what actually happens when people engage with data” (p. 102). Articulating a theory of change will help explain the mechanisms which bring about the desired outcome: improved decision making (Roderick, 2012). Without an understanding of that theory of change, it will be difficult to help individuals (such as principals) in unique situations (many different school settings) make the best use of their access to data provided by technology tools such as a data dashboard.

**Informing the North Carolina Home Base project.** The technology rollout which provides the impetus for this study involves an implementation occurring in stages, to various degrees, across the state during the next few years. Individual technology applications (PowerSchool for teacher grade books and attendance, for example) went live across the state in the fall of 2013. Other instructional improvement functions (Schoolnet, an assessment tool, for example) are optional and are just now being explored by many North Carolina school districts. The focus of the study proposed here is on the decision-making possibilities once schools have overcome the “fragmented nature of technology” (West, 2012, p. 9) and principals have access to a data dashboard which integrates the applications in a comprehensive interface. While a complex implementation such as the one across North
Carolina will eventually benefit from examination, it is too early to conduct an implementation evaluation. Certain key individual applications which will make up the dashboard (such as SchoolNet) are not widely adopted yet, for example. However, offering a rich understanding of program theory—a clarification of the program’s intended workings by expressing its theory of change—will provide timely information to state planners. The results will inform the implementation process and lay the groundwork for future evaluations, whether of the implementation, or of the program’s impact and cost effectiveness, evaluations which would be unfair and logistically unreasonable to conduct now.

The scope of the project in North Carolina translates to thousands of schools impacted by the implementation. Clarifying the program design, even a small portion of it, and comparing the intended design to an understanding of the design at the local school level, would offer a value sooner than an eventual implementation study. Weiss (1997a) differentiates implementation theory from program theory by defining the former as an understanding of the functioning of the intervention and the latter as an understanding of how the effects are meant to be obtained. By operationalizing the concepts inherent in the program design, and sequencing the expected events, program theory indeed offers an understanding of how the effects are meant to be obtained. This allows stakeholders to look at the chain of events and thus better understand the workings of the program itself. Program theory is important, Weiss (1997a) argues, for a future implementation evaluation and the eventual study of the program’s impact.

Finally, what Weiss (1995, 1997a, 1997b) has primarily called theory-based evaluation (based on a theory of change) “attends not only to what programs do, but also to
how participants respond” (1997b, p. 79). The voice of the practitioners must be heard for this study’s results to have the practical impact which is sought. Examining the theory of change and articulating the reality of the change mechanisms assumed to be in the program will offer “explanatory stories” (Weiss 1997a, p. 519) which have the power to communicate the findings of the study in persuasive ways. An approach to this research without principal stories would produce a superficial depiction of data dashboard use in an ideal world and would consequently offer limited tangible assistance to stakeholders. The principals are key participants in this study of the program’s theory of change, and the qualitative approach will provide a rich description of their professional context, reporting in depth on their perspective (Denzin & Lincoln, 1994).

**Logic Modeling**

Leeuw (2003) distinguishes program theory from program logic by explaining that program logic articulates the sequence of inputs and their links to short- or long-term outcomes. Program theory, in contrast, examines the assumptions underlying the logic in order to explain how exactly the program elements cause the outcomes desired. Although certainly evaluation scholars often see the logic model as a product emerging from a theory-based evaluation of a program (Rossi, et al., 2004; Wholey, 2004), Leeuw’s (2003) distinction between theory and logic serves to underscore the purpose of this study, which includes an examination of both theory and logic.

As part of the process of clarifying the program design and comparing to reality (Wholey, 2004), a visual diagram of the program (data dashboard use by principals) will be produced. This diagram, a logic model, will not remain static, inevitably even beyond the conclusion of this research, because as Sridharan and Nakaima point out, “interventions are
dynamic systems” (2011, p. 137). The nature of the principal context and the data technology will evolve, and the evaluation described here does not produce a summative assessment. However, creating the model at any point in time helps stakeholders understand each others’ perspectives (McLaughlin & Jordan, 2004) and the model will create a starting point for future evaluations (Whooley, 2004), whatever shape they may take.

Just as theory of change represented one among many terms for similar concepts differentiated by nuances, a logic model is also termed, for example, “an outcome map” (Annie E. Casey Foundation, 2004, p. 2), a “schematic representation” (Leeuw, 2003, p. 10), or “a plausible and sensible model of how the program will work” (McLaughlin & Jordan, 2004). It is frequently designed as a series of shapes connected by arrows to represent the connection points. The W.K. Kellogg Foundation presents a “basic logic model development template” (p. 17), shown in Figure 7, filled with sample content in Figure 8; and a “theory-of-change template” (2004, p. 28), shown below the basic models, in Figure 9. The third example demonstrates how a logic model can lead to an understanding of the evaluation focus and thus its design (2004, p. 36). All example logic model templates are from the W.K. Kellogg Foundation; copyright permission is found in Appendix B.

These possibilities, limited examples of the ways a logic model could take shape (McLaughlin & Jordan, 2004), suggest how a program design can be depicted visually. The most basic and familiar logic model is similar to the first example, Figure 7. The categories include resources (money, people, time), activities (offered as part of the program), outputs (data about participation in the activities), and outcomes (hoped-for effects). The W.K. Kellogg Foundation noted that short-term outcomes are results occurring within one to three years, and long-term outcomes are results occurring in four to six years. Impact is the “future
social change” the program hopes to achieve, occurring seven to ten years after the program begins. (2004, pp. 18-19). For more detailed examples of logic model sections, see Figure 8 which follows for a basic logic model example based on a fictitious reading program.

Figure 7. Basic logic model development template (with the permission of the W. K. Kellogg Foundation).
Figure 8. Sample logic model for a fictitious elementary school reading program (based on the logic model development template noted above). Note that the logic model and descriptions are simplified for illustrative purposes.

The second example, shown below in Figure 9, illustrates an approach to articulating the theory of change. It starts with the undesirable situation (1) which the program has been constructed to address, and then states the needs and assets in the program’s context (2). Articulating the desired results (3) means that planners have the beginning and the end and must subsequently examine the middle. How do program designers expect the plans to accomplish the results? The change process, therefore, consists of the identified influential factors (4) and the planned strategies (5), given certain assumptions (6). This practical theory development guidance framed the research process.
Figure 9. Theory-of-change template (with the permission of the W. K. Kellogg Foundation).

The final logic model example, Figure 10, shows how a logic model presents the evaluation possibilities. Evaluators can examine the program from any of several vantage points, such as implementation or measurement of outcomes. One way of viewing the proposed theory of change research is by considering the arrows depicted in this model. The arrows indicate, for instance, that certain resources and influences impact the program activities. The theory of change attempts to explain how that occurs. A key arrow links activities and outputs; if that link is weak, then the outcomes which follow cannot be reasonably expected. A measure of those outcomes without the assurance that the activities and outputs are plausibly connected offers no valid information. A study of the theory of
change underlying the data dashboard program will result in a logic model, with the reasoning of the program theory expressed fully. Armed with this information, state planners will be able to modify implementation, prepare future evaluations, and better plan the training of school staff.

![Logic Model Diagram]

Figure 10. A logic model which guides evaluation design (with the permission of the W. K. Kellogg Foundation).

Lessons from Program Theory Research

Four studies offer insight into the theory of change or logic model development process that is integral to the research proposed here (Carman, 2010; Crane, 2010; Leeuw, 2003; & Taut, Santelices, Araya, & Manzi, 2010). In 2003, Leeuw presented three methods for articulating program theory, detailing a case study example for each. One method, the “policy-scientific approach” (p. 7) is instructive for the data dashboard question, because it is situated in the domain of social science research and is well-suited for articulating program theory. This method relies on documents, interviews, and “argumentational analysis” (p. 9), or a logical examination of why people think a program will do what they expect. Leeuw (2003), as well as Crane (2010) and Carman (2010) frame their program theory as a series of
“if-then” statements. Looking at the logic model, Crane (2010) argued that if certain resources were applied, and if certain activities took place, then one could reasonably expect these outcomes. A visual representation of a logic model’s “if-then” framework is depicted in Figure 11. A certain amount of money, people, and time is necessary for the program to function (1), and if a program has access to those resources, then certain activities can take place (2), and if these activities do take place, then a service or product is delivered (3), and if those activities are accomplished, then program participants will benefit in certain ways (4), and if these benefits are realized, then certain long-term changes can be expected (5) (W.K. Kellogg Foundation, 2004, p. 3). The Annie E. Casey Foundation (2004) describes this logical progression as “a pathway of change” or “so-that chains” (p. 12). For example, the activities take place so that a service or product is delivered; the service or product is delivered so that program participants will benefit; and these benefits are sought so that a long term impact is made.

Figure 11. The “if-then” properties of a logic model (with the permission of the W. K. Kellogg Foundation).

Although evaluators often approach the program with a similar logical mindset (e.g., “if-then) they also approach their process of evaluation research in chronologically different ways, depending on the program, the context, and the evaluators’ expertise. Taut, et al. (2010) studied a teacher evaluation program in Chile, interviewing stakeholders from four
groups and creating a diagram of the program theory as articulated by each stakeholder group. Taut, et al. then compared these diagrams, investigating further those understandings common to more than one group. Carman (2010) developed a logic model based on documents and her own professional experience with non-profit organizations, then tested the model to discover its design flaws (p. 264) by comparing it to program reality, via documents. By consulting the research literature and documenting the reality of the non-profit's context, she showed the weak points in the theory of change. Crane (2010) collected and analyzed data for the identification of outcomes in the family development program she led, then used that data to refine an existing logic model.

Finally, in Leeuw’s (2003) case study about World Bank anticorruption initiatives illustrating the policy-scientific methodology, a six-step methodological process was followed. Consulting documents, conducting interviews, and reviewing the literature, the evaluators searched for statements that indicated expected behavioral mechanisms, seeking an answer to the question of how program planners thought the program would drive change. Examining these statements via argumentational analysis led to an understanding of the warrant, which Leeuw (2003) explained as the “because” piece of the argument (p. 7). With an understanding of the warrant (a part of the argument not typically explicit) the evaluator could look into the validity of the propositions, or the “if-then” statements. Evaluators began “charting the program theory” (p. 9), and created a logic model, which they then reviewed with stakeholders.

**How the logic model literature shapes this research approach.** Although the methodology of the data dashboard research is laid out in more detail in the next chapter, the influence of these four studies is summarized here. Leeuw’s (2003) six steps offer a guide to
the process of articulating theory, with steps including document and literature review, as well as interviews, and a logic model developed iteratively. Taut, et al. (2010) drafted several versions of a logic model, but organized them by stakeholder group rather than as an iterative evolution of theoretical understanding, an approach considered, but rejected, for this study. Given the early implementation stage of the dashboard technology in North Carolina, the current priority is to establish a general understanding of how dashboards and information systems are expected to trigger change. As established earlier in this literature review, the timing of the North Carolina Home Base project drives certain aspects of the research approach.

In Carman’s (2010) study of the accountability movement in non-profit organizations, the researcher examined documents and literature without interviewing participants, albeit guided by her own professional experience and extensive reviews of research. Carman's approach underscores the importance of documents, literature, and a researcher's professional experience. Nevertheless, for the North Carolina research study, interviews will be essential due to the range of Home Base project stakeholders and the need for insights from domains other than education. Crane’s (2010) study of a family development training program was based on earlier work and a previous logic model. Crane's work demonstrates the value of a thorough logic model to a program, however, for the North Carolina study no existing logic model of a principal data-based decision making process will serve as a starting point.

**Building on these approaches.** The data dashboard research proposed here will review the literature, examine documents, and interview stakeholders. The logic model will be drafted, presented to stakeholders, and revised as part of the interview process. The evolution of the logic model will be organized by a developing understanding of the
program. The professional experience of the researcher will be integral to an understanding of the decision-making process in schools. The terms theory of change, and the creation of a logic model, with its user-friendly vocabulary of “if-then” or “so that” will increase the approachability of the dashboard evaluation process and the likely utilization of its results by stakeholders.

This section began by enumerating the terms other than theory of change in the field of program theory. Evaluation scholars offer guidance to the theory of change process in general, and specifically to the approach of this study, despite differing terminology. Weiss (1997a) unequivocally stated that all programs have a theory. Commonly, these theories are implicit. This study intends to “surface the tacit theories” (Weiss, 1997a, p. 508), to “elucidate the theories” (Weiss, 1995, p. 66), to “make the reconstruction of underlying program theories transparent” (Leeuw, 2003, p. 17), or to conduct a “theory elaboration process” (Taut, et al., 2010, p. 485). The terminology varies, nevertheless, this data dashboard research ultimately seeks to make assumptions underlying program expectations explicit in order to answer the question of what principals need to profit from the data technology being implemented in their schools.

A Data Use Framework

Dashboards have the potential to help principals manage the intersection of external and internal accountability (Knapp & Feldman, 2012) to the benefit of their schools. This study examines the workings of dashboards in the decision-making process. In order to drill down to the practical mechanisms of dashboard technology which enable successful decision making, and in order to avoid an over-reliance on the buzzwords of school improvement, or data-based decision making, or even data use, the investigations of this study draw on the
framework described in this final section of the literature review. First, an understanding of the concept of knowledge utilization in schools (Cousins & Leithwood, 1993) strengthens the phrase *data use*. Furthermore, studying data use reality via the model provided by Spillane (2012) ensures a more coherent approach. With this approach, results will more likely lead to the intended illustration of how dashboards can (ideally) affect principal decision making, and thus what knowledge, skills, and dispositions are needed for effective dashboard use.

**A conceptual path from data to action.** *Data* are isolated and random when devoid of context, and become *information* when human beings interpret them, noting patterns or relationships. *Data* become *information*, and then finally *knowledge* only when human beings react and use the information (Petrides & Nodine, 2003). The technology systems (including dashboards) studied here exist to facilitate these processes. Researching data use, therefore, is a study of the human interaction with data in a certain context. In their discussion of school improvement, Cousins and Leithwood (1993) refer to the transformation of data to action as knowledge utilization, noting that it requires a "personal construction of meaning by those involved" (p.306). The question "What do you do with what you know?" (Choo, 1993, p. 337) also refers to the transformation of data to action, or *data use*, in an organization. The increasingly prevalent technology tools support the construction of meaning and subsequent action (Allio, 2012; Bienkowski, et al., 2012). Articulating the theory underlying the ideal use of these technology tools will guide school leaders who seek to leverage their use of data for more successful school improvement efforts.

**Studying data use in practice.** To move from conceptual to concrete, this study turns to Spillane's (2012) framework for studying data use in schools. Spillane describes “data use from the perspective of practice” (p. 114), with “practice” a term which refers to
the interactions of professionals with their responsibilities, given the constraints of their role and the resources they can access. In this data dashboard study principals are the professionals, and their particular context is the pattern of activities in a school. Spillane's framework forces an examination of interactions; how do the actors move in the atmosphere of their professional context? To understand the role of the principal, and the principal's data use, requires examination of interactions and systemic activities, and not an exclusive focus on a sole individual. In addition, these interactions are "cognitive in that they are about people perceiving, processing, and negotiating information" (Spillane, 2012, p. 127).

Highlighted in Spillane's (2012) work are “two aspects of organizational routines, the ostensive aspect and the performative aspect” (p. 115). The ostensive aspect is the ideal or planned routine, and the performative aspect is the routine in practice. Organizational routines include school improvement team processes, program management, responses to school-wide issues such as attendance or discipline. Two points are salient. First, Spillane carefully noted that his term “practice” does not simply equate to the performative aspect. The actors move in a system; any one organizational routine is but a part of that system, which is Spillane's definition of "practice". Second, for the purposes of this study, it is important to note that a comparison of the ostensive and performative aspects is not a research goal. The study attempts to define the ostensive aspect of dashboard use and articulate performative aspects of early dashboard use in North Carolina schools. Results will offer a baseline understanding of dashboards to educators in general and a window into the knowledge, skills, and dispositions of principals who will be successful with dashboard use in North Carolina.
Because the goal of this research is to produce “an understanding of how organizations and their members use data in practice” (Spillane, 2012, p. 118) both ostensive and performative aspects of data use merit attention. The chapter which follows will lay out in detail the methods of data collection, management, and analysis; however, an understanding here of the analytical framework will facilitate the organization of those details. In order to understand the effects of new technology on daily work, it is important to understand the organizational routines (both intended and in practice) already in play, and then the expected formal organizational structure of the newly adopted routines (use of data dashboard). The concepts of ostensive and performative “enables us to examine how school-level design and redesign efforts are informed by ... the institutional environment: how the macro informs the micro” (Spillane, 2012, p.119). They also allow for “insight into the ways in which the macro institutional environment becomes instantiated in everyday work inside schools” (p. 121). This is the research which will allow for a true understanding of actual work taking place in schools; an illustration of how the external demands and resources impact internal routines.

A focus on the performative aspect rightly places practice in the forefront of data use research. Moss (2012) noted that “we miss an important part of the picture when we focus, primarily, on the intended, the designed, and the formal” (p. 226). The performative aspect explains what data are truly used, and why. Spillane (2012) argued for a “real-time understanding” (p. 134) of data such that the study of practice was the focus of data use research. He noted that policymakers and planners cannot dictate practice; they can only “design for practice” (p. 136). If the school improvement goal is to improve practice, then
research must understand how practice works in general in order to expect change through an intervention.

Summary of Literature Review

North Carolina's Home Base technology motivates this study. Technology investments in the state offer schools tools with the potential to produce transformative change in educators’ data use. Three main areas of literature reviewed in this chapter established the background necessary to understand and delimit the research problem. First, the study focus on the school (rather than the classroom, or the district or state) and more particularly on the principal, was explained via previous research which studied principal effects and school-wide data use. Principal research includes findings which demonstrate the utility of data tools like dashboards. For example, dashboards can facilitate the situational awareness which principals need to be successful leaders of a school (Few, 2013; Marzano, et al., 2005).

The second section reviewed key developments and terminology from business research as well as dashboard technology. Kaplan and Norton's (1992) Balanced Scorecard offers insights to education, relating to Bernhardt's (2004) Multiple Measures of Data for an improved lens through which to view data-based decision making. Terms such as key performance indicators and analytics, as well as dashboard itself, are more familiar in other research domains and merit attention in education. Data visualization is a field less well known in education but which offers solutions to users who want to make better sense of their information. The potential of a dashboard to corral information overload for educators also deserves exploration.
The last of the three main sections of the literature review explained the program theory approach to understanding successful data dashboard use. The domain of program evaluation offers a practical way to model this understanding. The type of program evaluation research in this study is classified as an assessment of program theory, or an examination of the "assumptions and expectations" (Rossi, et al., p. 54) of the program, with the program defined as dashboard use. A visual diagram, or logic model, is a product often emerging from a theory-based evaluation of a program (Rossi, et al., 2004; Wholey, 2004). Logic models will help articulate how information technology can trigger change in the decision-making processes of principals. This visual presentation of the mechanisms of dashboard use will result in an improved understanding of the knowledge, skills, and dispositions of principals successful with data dashboard use.

The literature review concluded with a brief discussion of concepts underlying the often over-used terms *data use* and *data-based decision making*. Then, Spillane's (2012) framework is described in order to move the research approach from concepts to a concrete framework for studying data use in schools. Spillane noted that his framework is a pragmatic one, relying on multiple conceptual and analytical tools. Articulating how individuals notice, perceive, and process data such that it becomes information, and delineating the context, or the pattern of activities which aid in this data-to-information process is inherently a complex, multi-dimensional work (Breiter & Light, 2006; Cousins & Leithwood, 1993; Petrides & Nodine, 2003; Spillane, 2012). Furthermore, the reaction to information, the understanding which occurs, and the subsequent choice of actions to take; this is finally data become knowledge transformed to decision making (Petrides & Nodine, 2003). Multiple conceptual
and analytical tools will accomplish what an impractically single-minded focus cannot. In the next chapter, this pragmatic reasoning is shown to be a driver of the methodological choices.
METHODS

Many states are equipping public schools with technology which has the potential to serve as a data dashboard, providing at-a-glance information on a number of indicators. It is increasingly important to understand how descriptions of data use in practice interact with the intended functioning of this technology for school principals. This understanding is essential in order to articulate the knowledge, skills, and dispositions principals must have to make good use of data technology for their decision making. The theory-based evaluation (Weiss, 1997a) in this research is structured as a qualitative case study (Creswell, 2007; Stake, 1995). The Home Base technology project in North Carolina serves as a major motivating circumstance, prompting research attention to dashboard use for data-based decision making for organizational management and program planning.

This chapter outlines the research approach and includes a rationale for design choices. First, an explanation of the qualitative approach, and particularly of the case study design, connects the overall approach to the research needs. Next, I document personal positionality and subjectivity, and detail the worldview which frames the approach to the study. Next, details are provided for the design, the expected participants, the data collection (interviews, document analysis, and observations), the data analysis and expression, and finally, validity and reliability concerns are addressed.

A Qualitative Approach

In this section of the chapter, the qualitative approach is defined and shown to be appropriate for this study. Qualitative research “is designed to uncover or discover the meanings people have constructed about a particular phenomenon” (Merriam, 2002, p. 19). It is reflective in nature (Creswell, 2007) and “seeks depth rather than breadth” (Ambert, Adler,
Qualitative research focuses on the meanings constructed in a particular context by the participants themselves. Also, the researcher elicits from participants their lived reality, and endeavors to allow their voices to construct the meanings. The researcher functions as an interpreter for the participant perspective, allowing the participant time and opportunity for reflection and then the researcher reflects about the meaning of what has been expressed (Creswell, 2007). This interpretation is an art, where the qualitative researcher presents the full complexity of the participants’ stories and allows readers “to live their way into an experience that has been described and interpreted” (Denzin, 1994, p. 506).

A qualitative approach is fitting in the context of a complex implementation. An awareness of the strengths and weaknesses of the principal actors and the system in which they operate prior to implementation is vital (Fixsen, Naoom, Blase, Friedman, & Wallace, 2005). New products with great potential often founder or go awry because of limited institutional readiness for implementation (Bienkowski, Feng, & Means, 2012). Hall (2010) called high-quality implementation the “Achilles heel” (p. 232) of technology innovations. Studying the assumptions of a program and how those assumptions are operationalized, or in other words, studying the program’s theory of change (Weiss, 1995), is a way of understanding the potential impact of a data technology innovation and can improve its implementation.

Qualitative inquiry is best suited for perceiving the underlying meanings (Merriam, 1988) not only of the technology innovation and the resulting new routines, but also of the ongoing routines of the setting. In addition, the North Carolina project motivating this research has not progressed to a stage where a quantitative study that measures impact is
appropriate. For these reasons, qualitative research is the best choice at this time for an understanding of dashboard use in the principal context in North Carolina. Finally, principals, those closest to the reality of the Home Base rollout, are at the same time those whose voices are least often heard. Qualitative research meets the need to allow practitioners to speak; to “hear silenced voices” in the local schools (Creswell, 2007, p. 40).

Philosophical Assumptions

My ontological assumptions (Creswell, 2007) reflect the reality of practitioners from myriad domains (e.g., health care, higher education, K-12 technology leaders and principals) interviewed for this study. These voices come from various points along the continuum of decision making with a data dashboard. The study proposed here has the “intent of reporting these multiple realities” (Creswell, 2007, p. 181). Through the input of these practitioners a full perspective of the data tool experience becomes clear.

My epistemological assumption (Creswell, 2007) is that as a practitioner with many years of experience in schools, I can minimize the distance between the participants and myself. I can be a credible interviewer because I have an extensive background in public education (which will be made explicit later in the chapter) which is similar to that of many participants. In addition to describing myself as an education professional, I describe my potential personal biases and articulate the values I bring to the research. The process of describing myself as an interviewer and recognizing potential biases allows this research to offer credible understanding of the nascent reality of North Carolina’s data-based decision making with Home Base. By openly expressing what may be axiological issues, I “admit the value-laden nature of the study and actively report [my] values and biases as well as the value-laden nature of information gathered from the field (Creswell, 2007, p. 18).
Case Study

This section defines and defends case study as a suitable choice for this research. In addition, this section situates the case study portion of the research within the larger research plan. As a systematic research design, case study is appropriate in applied areas (such as education) which “value research as a means of understanding, informing, and improving practice” (Merriam, 1988, p. 6). Case study “involves the study of an issue explored through one or more cases within a bounded system” (Creswell, 2007, p. 73) and is defined with specificity (Stake, 2005). The unit of analysis (the case) in this study is the use of data dashboards by K-12 school principals in North Carolina. The case is delimited to the practice of data-based decision making by principals; with practice framed as a system of interactions involving intended and actual routines (Spillane, 2012).

A case study is an effective research method for learning in the domain of public education, and in this situation particularly, as the goal is to describe a process (Merriam, 1988). The expected outcome of understanding that process is the ability to increase effectiveness on the part of principals for using a data dashboard when making decisions. Moreover, case study research elicits the kind of learning which moves beginners to experts (Flyvbjerg, 2006), because qualitative case studies produce “context-dependent knowledge”, which, far more than “rule-based knowledge”, develop experts (pp. 221-223). That context, as previously discussed, is a product of the external demands and the internal system (Knapp & Feldman, 2012), and further, must account for more than just one individual and his or her circumstances (Spillane, 2012). The importance of that context, argued Moss (2012), makes “a compelling case” for “in-depth study . . . to illuminate the ways institutional logics interact with the contingencies of local circumstances” (p. 229). Case study, as a method for in-depth
study of a principal’s professional reality, is uniquely appropriate for the development of understandings to improve the practice of data use by principals in schools.

**The North Carolina Context**

This section describes the case, and discusses the benefits and limitations of a case study. The issue in this study is the use of data dashboards for principal decision making. North Carolina’s Home Base implementation motivates the focus and functions as the case. The state’s Department of Public Instruction has begun what will be an extensive rollout of new and updated technologies for myriad purposes. The immediate focus is on the classroom: aligning instruction with the Common Core Standards and organizing teacher evaluation (Price, 2012). However, long-term goals include improved decision making for the school’s principal.

The current research and practical need is for a baseline understanding of the decision-making possibilities with a product like Home Base. Thus, a “hypothesis-generating” approach is called for, rather than a “hypothesis-testing” one (Merriam, 1988, p. 3). The inquiry in this study is exploratory in the sense that dashboards are a new phenomenon in education and the research base for use of dashboards in schools is not developed. This study is also an instrumental case study because it “is instrumental to accomplishing something other than understanding this particular [program]” (Stake, 2005, p. 3). This study seeks to offer insight helpful to practitioners who seek to prepare school principals for their decision-making possibilities, with an immediate benefit from the results to North Carolina.

Within North Carolina, schools vary immensely; some are farther along the data use continuum than others. For already high performing districts, Home Base may not at first
appreciably improve their decision-making process. By and large, urban districts have had better access to data than smaller or rural ones, but also have more layers of central office staff between the practitioners and the state. As a state-wide innovation, Home Base may affect the implementation in larger districts that heretofore independently designed major technology changes. The change will happen to a greater and lesser extent across North Carolina public schools. The full description from an in-depth case study allows readers to assess the transferability to their own situations. Qualitative research meets the needs of this study because it “stresses the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry” (Denzin & Lincoln, 1994, p. 4, emphasis added). The potential of Home Base is transformative; changing the data use landscape in North Carolina’s public schools, regardless of their size, location, or performance.

An implementation study is inappropriate at this stage, but may fit research needs in two to three years when the suite of technology products which comprise Home Base are functioning in more North Carolina schools. At that point, researchers may ask how well schools are implementing Home Base into their decision-making processes. Home Base is unevenly functioning at this point, and operation across the state is not yet realized. Now, researchers can hope to impact the development for implementation, as well as the planning for training, by providing role-based information. By starting with an interpretivist approach (Creswell, 2007; Denzin & Lincoln, 1994; Holstein & Gubrium, 1994; Schwandt, 1994; Stake, 1995), the study proposed here reports the perspectives of principals as the key players in school decision making such that policy makers, district leaders, and future researchers
take action based on a fuller and more nuanced understanding of the interaction of principals with their data.

While a case study unquestionably provides deep understanding of a single issue, the rich insight comes at the price of breadth of information. Merriam (1988) noted that “the holistic description is at once a strength and a limitation” (p. 35). Glaser and Strauss (1967) emphasized “the ‘real life’ character of fieldwork” and the value of “a firsthand immersion in a sphere of life and action” (p. 8). Here, the context, timing, and nature of the questions means that case study is an excellent fit for this research design. With this study, consumers of the research have extensive information and will be able to determine the applicability to their own situations.

This research also sheds light on future directions for a more robust study of this issue. Nowhere is the impact of educational technology innovations more real than in the day-to-day life of the school. Immersing the research there and reporting from firsthand witnesses to the effects of the change leads to practical recommendations to North Carolina on how to improve the conceptualization of Home Base as it relates to principal use of data to inform school-wide decisions.

Positionality and Subjectivity

In this section, I detail the impact of my practitioner background on this research and certain design choices, and conclude with an explanation of the connection between my own worldview and a qualitative approach. Punch (1994) recommends an understanding of the “personal and intellectual path” (p. 86) which lead to the choice of topics and methodologies. I come to this research after more than two decades as a classroom teacher, as well as having
led or participated in numerous school-wide initiatives, often as action steps articulated in a school improvement plan.

The grueling schedule of the school-based practitioner often allows little time for reflection or data analysis, and yet principals and school improvement teams spend too much time doing what I call *chasing* school programs. By this I mean that there never appears to be adequate time for planning, data analysis, or evaluation. Educators often invest many hours in awkward implementations, or in the management of ongoing programs no one can say are effective. Many of these programs are costly as well. Time appears to many practitioners to be simply unavailable for planning prior to action, or evaluation, and yet ultimately that time is spent nonetheless on potentially fruitless implementations or on questionable programs.

Practitioners can thus be in the position of using their limited time without the benefits they might have achieved from more functional planning and evaluation. The obstacles of “collective inquiry into practice while in the midst of the urgencies of practice” (Copland, Knapp, & Swinnerton, 2009, p. 171) are overwhelming. Through the years I have determined that practitioners need help in order to front load the time requirements of their programs and organizational management issues by adequately planning and evaluating while simultaneously keeping the school running and teaching the students. Practitioners are spending time on awkward implementations and questionable programs; time that they say they do not have, yet often without the benefits they might achieve from more appropriate programming efforts.

With the advent of sophisticated data management systems such as technology infrastructure designed to facilitate information access, I sense an opportunity to overcome the obstacles. If a school staff now has an interface with data allowing them to incorporate
data-based decision making into the daily routine, the potential for improving school processes is significant. These information management systems, whether they are called dashboards or not, may become a revolutionary tool for school improvement. Because of my belief that the ultimate point of scholarly research in education is to impact practice, the goal of this study is to enable practitioners to profit from the data tools at their disposal. These tools, initiated by external forces, can become important resources for internal excellence. I want to help principals become successful by taking the external demands for data use, with the associated resources provided, and translating that to an internal culture which leads to authentic school improvement (Knapp & Feldman, 2012).

**My Practitioner Experience**

As a teacher I was influenced by the pressure of strategies implemented and professional development planned without enough prior investigation. The process of understanding an innovation, investigating the context, and then determining the needs of the individuals impacted is a sequential one. This research first explores what the data dashboard process of use entails in order to better understand user needs. The case study portion provides North Carolina decision makers with information to better prepare current and potential users for effective and efficient use of dashboards.

Having taught in middle and high school in several subject areas for more than twenty years, with experience in major districts in three different states, I am afforded a perspective of time and geography which bring advantages to the research. I am not limited to a single context, but can ask questions and analyze data with an eye to a variety of school scenarios directed from a variety of leadership styles. However, my diverse background of classroom and school knowledge does not allow me to speak from a principal’s perspective, as I have
not served a school in that capacity. I compensate for that by reflecting on the many leadership roles I have held, working closely with a number of principals and assistant principals over the years, as well as by drawing on the rich body of research literature which addresses the principal's role. My school improvement experiences have provided me a school-wide perspective not present in the average teacher’s mindset, as well as a thorough understanding of the school initiative planning and implementation process.

Situating my research in the local school fits my background. It also fills an information void occurring when “researchers [who] were not experts in curriculum or pedagogy [have] avoided studying the relationship between policy decisions at the school board level and what happened in the proverbial black box of the local school site” (Wells, Hirshberg, Lipton, & Oakes, 1995, p. 20). I am well versed in the "black box of the local school site" and can help fill that information void.

**On Being a Bricoleur**

In this section I explore the nature of being a *bricoleur*; the connection between teaching experience and a pragmatic approach to research. The qualitative researcher is a *bricoleur*, a term applied to those who use “a pieced-together, close-knit set of practices that provide solutions to a problem in a concrete situation” (Denzin & Lincoln, 1994, p. 2).

Teachers must often function as *bricoleurs* as they confront myriad challenges from a wide range of children in their classrooms (not to mention challenges from parents or colleagues), and therefore I have developed a strength for performing diverse tasks without a rigidity in my approaches. I will do whatever works with no ideological commitment to a particular method. I am also a realist and seek a practically applicable set of research findings which stakeholders can understand. It is important to note though, that finding concrete
answers to a particular, localized question should not be the only purpose to this or any research. I seek to advance the theoretical understanding, for example, of the issues at stake in this study: the interaction of principals with a school’s data and the nature of changes expected to occur in data-based decision making with the implementation of a sophisticated data tool. In this regard, I concur with Johnson (2009) who, although he argued for a pragmatic vision and concrete guidance for education stakeholders, also emphasized that “determining ‘what works’ is not the only purpose of educational research” (p. 455).

A Bricoleur, But Not a Flâneur

Finally, lest the term bricoleur be perceived as one who is flighty or without scholarly heft, the bricoleur should be distinguished from the flâneur (Weinstein and Weinstein, 1991). The flâneur wanders about. In French, flâner means to stroll, without true purpose or destination. Bricoler, on the other hand, means to build or create with materials available in an efficient manner. The decisions for methodological approaches in this study were not made lightly, nor applied carelessly. Qualitative inquiry by its very nature employs multiple methods as needed to understand the issue (Denzin & Lincoln, 1994), but this in no way implies a haphazard or impetuous approach to the research. Details of the methodological design of this study demonstrate the power of a pragmatic approach, and also provide proven structure to the design.

Overview of the Study

The purpose of this overview is to offer a bird’s eye view of the research design prior to laying out methodological choices and explanations in detail. This section concludes with the research questions. The study employed a qualitative case study design (Creswell, 2007; Stake, 1995) and collected data for a theory-based evaluation (Weiss, 1997a) in order to
explain how data technology tools impact decision making. The purpose is to discover what knowledge, skills, and dispositions principals need to use a data dashboard tool to improve decision making. A theory-based evaluation is described by Weiss as a study of the “beliefs and assumptions underlying an intervention” (1997a, p. 501). Data collection focused on the “four basic sources of information about an intervention’s theories: documents, people, prior research, and logical reasoning” (Weiss, 1997a, p. 508). Seeking out the information from these sources led to articulating the logic of the intervention, or the program, which is the data technology tool known as an integrated platform or dashboard.

The bulk of the data collected came from interviews. Supplementing the interviews were observations of trainings, and analysis of planning materials and other documents. Data collection began broadly and concluded with a more narrow focus on the North Carolina context. Data analysis occurred in tandem with ongoing data collection. Transcriptions as well as researcher logs and memos were uploaded into the qualitative software Atlas.ti (ScientificSoftwareDevelopment, 2013, Version 7). Although an initial set of codes were identified based on the literature, the analysis allowed for emerging codes.

**Research Question**

This research approaches its central question with a program evaluation mindset. Within the field of program evaluation, particularly in the early stages of a program, is the need to articulate the theory of change underlying the expected impact of the program (here, the dashboard). The creation of a logic model, or a visual diagram, is a typical outcome of this type of program evaluation (Rossi, Lipsey, & Freeman, 2004). In this case, the diagram models dashboard use by school principals and the change mechanisms which lead to the hoped-for improvements in data-based decision making. The engine driving this program
evaluation work is the need to offer professional development to the school principals who play such a vital role in the school’s improvement efforts. Articulating the theory of change, creating a logic model, and providing a description of a state-wide implementation are the strategies to answer the central question of this study.

What knowledge, skills, and dispositions contribute to effective principal use of data dashboards to inform systemic school improvement?

**Sampling and Participants**

This section offers a description of study participants and their expected contributions to the research. The observation and document analysis are described in later sections. The interview participants were contacted via email, given a short description of the study, and asked to interview with the researcher in person, at the participant’s office or other convenient location, one time for 45 minutes. Appendices C-E contain communications, from the initial contact to the messages thanking the interviewees for their participation. Interview protocols and the nature of data management (recording and transcription) are described in later sections. Eighteen participants were interviewed and were organized in two phases. In both Phase 1 and Phase 2, the researcher presented the purpose of the study and obtained written consent from the interview participants. No identifying information is used in the study, including the names of companies or schools where participants are employed.

To accomplish the goal of explaining the influence of factors on the activities and output of the dashboard logic model, the researcher used an interpretive qualitative study design (Denzin & Lincoln, 1994; Merriam, 2002) to investigate the knowledge, skills, and dispositions of successful dashboard users in domains where dashboards have a longer history and more robust research literature (Phase 1). To demonstrate how a theory of change
can be used to inform K-12 principals’ current use of data dashboard to inform school improvement, and to offer targeted recommendations to North Carolina and other states implementing data technology, the researcher used North Carolina's Home Base as a case study (Phase 2). This section summarizes the interview participants from each phase and describes how they were recruited.

**Phase 1 Interview Participants**

By beginning the data collection with dashboard experts, the best understanding of the industry shaped the subsequent research. The gathering of this information maximized researcher understanding of the database tool prior to speaking with sources in education. Interview participants for Phase 1 were recruited through the researcher's professional network and via recommendations, a form of snowball sampling, which resulted in the identification of other “information-rich cases” (Punch, 2006, p. 51).

Table 2 describes the five industry professionals, four from top tier consulting and technology firms, representing three domains (health care, higher education, and state and local government).

<table>
<thead>
<tr>
<th>Title of Participant</th>
<th>Domain</th>
<th>Type of Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chief Analytics Officer</td>
<td>Health Care</td>
<td>Management consulting, technology services and outsourcing</td>
</tr>
<tr>
<td>Business Advisor</td>
<td>Health Care</td>
<td>Health care information technology</td>
</tr>
<tr>
<td>Senior Account Executive</td>
<td>Higher Education</td>
<td>Business analytics software and services</td>
</tr>
<tr>
<td>Web Development Manager</td>
<td>Higher Education</td>
<td>Nonprofit which administers education loans and scholarship programs</td>
</tr>
<tr>
<td>Senior Manager</td>
<td>State and Local Government</td>
<td>Business analytics software and services</td>
</tr>
</tbody>
</table>
local government). The five participants were each interviewed one time for approximately one hour. Participants in North Carolina (3) were interviewed in person and others (2) were interviewed by phone. All but one of the interviews were audio-recorded and transcribed. During the one interview which was not recorded, the researcher took extensive notes. These industry expert interviews were conducted from October through December 2014.

**Phase 2 Interview Participants**

Participants for Phase 2 were recruited through the researcher's professional network, industry literature, and via recommendations (snowball sampling). Table 3 outlines the thirteen participants from education—school administrators, district officials, state planners, and one technology vendor— who were interviewed from March through September 2015. The participants met with the researcher on average for an hour. Three were interviewed on the phone, and the other ten were interviewed in person. All but one of the interviews were audio-recorded, and during that one interview, the researcher took extensive notes. Following Table 3, this section continues with an explanation of the classification of North Carolina participants as SchoolNet users or non-users, and then provides detail as to each participant's role and how each was chosen to participate in the study.
Table 3

**Phase 2 participants**

<table>
<thead>
<tr>
<th>Title of Participant</th>
<th>Domain</th>
<th>Location</th>
<th>SchoolNet?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Specialist</td>
<td>Central office of a school district</td>
<td>Outside North Carolina</td>
<td>no</td>
</tr>
<tr>
<td>Assistant Superintendent for Instructional Technology (retired)</td>
<td>Central office of a school district</td>
<td>Medium-sized city (North Carolina)</td>
<td>no</td>
</tr>
<tr>
<td>Technology Vendor from the Home Base Implementation Team</td>
<td>Vendor working with NC DPI (Home Base)</td>
<td>Raleigh, NC</td>
<td>yes</td>
</tr>
<tr>
<td>NC DPI Presenter</td>
<td>Division of Digital Teaching &amp; Learning</td>
<td>Raleigh, NC</td>
<td>yes</td>
</tr>
<tr>
<td>NC DPI Staff</td>
<td>Division of Digital Teaching &amp; Learning</td>
<td>Raleigh, NC</td>
<td>yes</td>
</tr>
<tr>
<td>Curriculum Specialist</td>
<td>Elementary School</td>
<td>Small town (NC)</td>
<td>yes</td>
</tr>
<tr>
<td>Director of Testing and Student Information</td>
<td>Central office of a school district</td>
<td>Medium-sized city (NC)</td>
<td>yes</td>
</tr>
<tr>
<td>Assistant Principal</td>
<td>Elementary School</td>
<td>Large city (NC)</td>
<td>no</td>
</tr>
<tr>
<td>Elementary Principal (A)</td>
<td>Elementary School</td>
<td>Rural area (NC)</td>
<td>no</td>
</tr>
<tr>
<td>Elementary Principal (B)</td>
<td>Elementary School</td>
<td>Small town (NC)</td>
<td>yes</td>
</tr>
<tr>
<td>Middle School Principal</td>
<td>Middle School</td>
<td>Small town (NC)</td>
<td>yes</td>
</tr>
<tr>
<td>High School Principal (A)</td>
<td>High School</td>
<td>Rural area (NC)</td>
<td>no</td>
</tr>
<tr>
<td>High School Principal (B)</td>
<td>High School</td>
<td>Rural area (NC)</td>
<td>no</td>
</tr>
</tbody>
</table>

Implementation of Home Base has varied widely across the North Carolina. Even though the optional products (including SchoolNet) are offered for $1 per student, instead of
the anticipated $3.74 ("Home Base Pricing for 2015-16"), many districts, particularly larger ones, have declined to participate. Among the districts which have committed to SchoolNet, some marvel at the online gradebook which has long been standard operating procedure in others. In addition, districts may struggle with philosophical opposition to sharing student data, thereby limiting online access or successful work with Professional Learning Communities. Ultimately, connectivity varies across the state. One-to-one schools (those with a laptop or Mac Book for each student) may find themselves unexpectedly ahead of the assessment curve, albeit perhaps less well equipped for the necessary analysis. For all these reasons, findings from this study related to people's knowledge, skills, and dispositions do not fit neatly in two categories: Home Base users or non users. Dividing users strictly as either technology adopters or non-adopters is superficial and simplistic (Hall, 2010). Implementation is a continuum or a process, not an either-or categorization (Fixsen, et al., 2005, p. 15).

For the purposes of this study therefore, a Home Base user is defined as a North Carolina school or district staff member in a district which has committed to the additional products in the Home Base suite of tools. The single additional product discussed in North Carolina at this time is SchoolNet. Three of these seven SchoolNet users are NC DPI staff or are employed by the technology vendor, and four are school or district staff (one elementary principal, one middle school principal, one curriculum specialist based at an elementary school, and one director of testing and student information in a district office). The NC DPI staff were interviewed as a result of connections made when the researcher attended SchoolNet trainings. The NC DPI presenter serves in a dual role at NC DPI and with a particular school district elsewhere in the state. The NC DPI staff is part of the Home Base
leadership team. The technology vendor was connected to the researcher through a university training for pre-service teachers held in 2014. The principals identified as SchoolNet users come from one North Carolina school system, and the other participants come from two additional school systems. These four school or district staff were identified by NC DPI or the technology vendor staff as strong users of SchoolNet and then contacted by the researcher.

The six other interview participants, listed as SchoolNet non-users, include a research specialist who works in the district office of a school system in a neighboring state, and a retired assistant superintendent for instructional technology from a North Carolina district. Both these participants were recruited because they appeared as exemplars in industry literature published by a technology company known for its business analytics software and a significant presence in the education market. Neither this particular technology company nor these two participants are connected to North Carolina's Home Base product or its technology vendor. The remaining four participants are from four different North Carolina public school systems. One is an assistant principal at an elementary school, another is a principal at an elementary school, and the other two are high school principals. These principals were recruited through connections in the researcher's professional network. They were also recommended as strong data users.

For this study, a purposeful sample of participants was chosen for their potential to help answer the question. The review of the literature also guided the choices of interviewees. Purposive and theoretical sampling often direct qualitative research (Marshall & Rossman, 2006). Each individual who participated in this study had a perspective of data-based decision making, and the research goal is to discover and portray these multiple views
(Stake, 1995, p. 64). Although embarking on these interviews with as much background knowledge as possible, and with a thoughtfully prepared list of questions, ultimately I exercised common sense and “remember[ed] that each individual has his or her own social history and an individual perspective on the world” (Fontana & Frey, 1994, p. 37). Keeping in mind the political context and the professional motivations of the participants (Leeuw, 2003; Taut, Santelices, Araya, & Manzi, 2010; Weiss, 1995) I described as faithfully as possible the data dashboard logic model.

The next section explains data collection methods, and includes descriptions of the observations and document analysis.

**Data Collection**

This section describes the interviews, which constitute the majority of the data sources, the observations and document analysis, and then data management procedures. The interview protocols for each set of participants are laid out in Appendices F-I. In general, interviews began with a casual opening question concerning the participant’s professional experience, then continued with a question to draw out experience or professional responsibilities specifically related to the data tool. The key question asked of principals was a request for examples of dashboard use (e.g., “Could you tell me about a time when...” or “Can you give me an example of ...”). Finally, participants had the opportunity to describe obstacles or crucial professional development. Before concluding the interview, the researcher requested recommendations for additional interviewees, and thanked the participant for his or her time.

Interviews are essential because “the processes being studied are nearly invisible” (Rubin & Rubin, 2012, p. 5). The complex blend of individual knowledge and skills,
systemic resources, and other contextual factors produce a data-based decision-making phenomenon which cannot be superficially captured. The structure of the conversations to take place in this study was thoughtfully planned, but consisted of responsive interviewing (Rubin & Rubin, 2012) which allows for individualized follow-up questions, rather than a fixed list of interview questions. The researcher carefully prepared for each conversation by becoming familiar in advance with easily discoverable information (publicly available school details, for example) and thus used the participant’s time efficiently. This familiarity also established the interviewer as an informed person and facilitated explanations. Preparation for each interview also included analysis of previously collected data. In this manner, the interviewer was prepared to create appropriate follow-up questions or probes on the spot.

**Semi-Structured Interviews**

All interviews were comprised of one-on-one semi-structured interviews conducted in person (13) or by telephone (5), with an outline of the interview sent to the participants prior to the interviews upon request. In an instructional essay related to interviewing busy CEOs, Thomas (1993) recommended semi-structured interviews. He suggested submitting questions to the interviewee in advance, in order to expedite the interview, but with the researcher able to retain, however, a measure of flexibility. As the CEO of the school, a principal similarly has a busy schedule, so the researcher conducted the interviews quickly and efficiently, albeit diplomatically. The benefit of sharing the planned structure of the interview is that the principal had time to reflect on the topics of interest to the researcher. Because this study interviewed each participant one time, maximizing the data gained in the time allotted was a priority.
In addition, Qu and Dumay (2011) described the semi-structured interview as appropriate for a “localist” approach, where “the localist position is based on understanding interviews in a social context, instead of treating [interviews] as a tool for collecting data in isolation” (p. 242). Their classification guides this study’s interview design. The interviews in this study are not expected to provide data free of the context of the participant with a goal of uncovering an objective reality. If that were so, a structured interview would be more appropriate. Neither are this study’s interviews intended to foster a close relationship between the researcher and the principal participants, with the intent of exploring the principals’ inner world; an unstructured design would be better suited to those goals. These authors have suggested, and the study proposed here adopted, the reasoning that semi-structured interviews best fit “a localist view [which] offers an alternative way of conceptualizing interviews as a situational account of a phenomenon” (Qu & Dumay, 2011, p. 245).

The interview protocol detailed the scheduled questions, but the semi-structured design allowed for follow-up questions or probes (Rubin & Rubin, 2012) to draw out more complete information from the interviewees. The researcher sought responses that include concrete details and enough descriptive information to articulate the process of using a dashboard while concentrating as much as possible on the individual level knowledge, skills, and dispositions which enable or constrain effective use by the principals.

**Ethical Responsibilities in Interviewing**

The researcher made straightforward explanations of the purpose of the interviews and obtained written consent prior to each interview; examples of the informed consent can be found in Appendices J. Because the nature of this qualitative study is to highlight
successful use of an exciting new tool—a dashboard—it is unlikely that interviewees would be harmed by participation in the study. However, they were guaranteed confidentiality. Their wishes concerning the use of their name or organization were discussed up front and meticulously respected throughout data collection, analysis, and reporting of findings. If the participant desired confidentiality, then the audio recording of the interview was transcribed using pseudonyms and the original recording erased. All field notes were transcribed similarly and the originals destroyed. The references to the school or organization in the data analysis were structured so that the details cannot identify a particular school or individual.

According to Weiss (1994) a “research partnership” (p. 65) is the most successful structure for the interviewing relationship. In such a relationship, the interviewer respects the respondent’s expertise and opinions while also ensuring that the respondent will not be disadvantaged in some way due to his participation in the process. The researcher guided the interview topics while constantly monitoring the use of the respondent’s valuable time. The participants targeted for interviews in this study, whether familiar with the use of data dashboards or not, appreciated the research gap which exists in the field of data tools for K-12 education, and valued efforts to reduce that gap. In this case, these industry experts, state planners, and school leaders will play an essential role throughout this study to further the cause of increasing public education’s effective use of data dashboards for decision making.

The researcher approached the interviews with the intent to establish a conversational relationship (Rubin & Rubin, 2012; Weiss, 1994) and with respect for participants’ work, and their willingness to assist the research. The qualitative work was about “exploring, describing, and explaining a complex situation” (Rubin & Rubin, 2012, p. 49) with an appreciation for the professionals who share their experiences.
Documents

Publicly available documents which explain or encourage the use of North Carolina's data system were analyzed in conjunction with the interviews in Phase 2. The selected documents were publicly available online, and free, thus accessibility is assured (Hodder, 1994). These documents help determine the terminology (e.g. dashboard, integrated platform, or scorecard) that has been chosen to represent the technology. Documents further provided examples of anticipated use of the technology. For example, the presentation slides prepared by North Carolina’s Home Base planners include several scenarios meant to provoke discussion of potential use (“CCRESA Meeting,” 2013). These types of documents not only point to the vocabulary chosen, but also to the meanings which appear to be attached to them. They further illustrate the ways in which planners intend data system use to affect operations. In this way, documents contributed to the development of the logic model which represents the expected change process and to an understanding of the triggers viewed as causing the change.

While any written material can be considered documents (Merriam, 1988) documents may also be distinguished from records, where the latter include official materials and the former, personal letters or notes (Hodder, 1994). When referring to documents, the intent is to refer to officially prepared reports, presentations, or marketing materials, in Hodder’s (1994) sense of records. These materials were examined in the context of the interviews which were the core means of data collection. For example, when interviewing a principal experienced in the use of data dashboard technology, a review of the materials led to a more nuanced conversation (Merriam, 1988). In this case, a review of documents produced by the
school or district led to a better understanding of the school data terminology and also
generated concrete examples of dashboard use as topics for discussion.

Documents were mined for two main purposes: first, to establish the terms used to
refer to the data technology and the meanings attached to those terms; and second, to provide
examples of expected data technology use. The document review was organized by a form of
content analysis, using a “systematic procedure for describing the content” (Merriam, 1988,
p. 116). Appendix K includes a basic data collection form which organized the assessment of
the documents and noted the targeted data collection (technology terms and meanings;
examples of use or expected use). Based on Merriam’s (1988) suggestions for investigating
documents, the data collection form information included the origins of the document and its
purpose or intended audience. Table 4 below describes the documents analyzed. Each
document was downloaded and kept on the researcher’s personal computer, backed up with a
dedicated flash drive, similar to all other research materials.
Table 4

Documents analyzed

<table>
<thead>
<tr>
<th>Title of Document</th>
<th>Date</th>
<th>Author</th>
<th>Intended Audience</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Resource Guide</td>
<td>Spring 2013</td>
<td>NC DPI</td>
<td>Schools</td>
<td>33 pages</td>
</tr>
<tr>
<td>Home Base</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communications Best Practices Guide</td>
<td>2014</td>
<td>NC DPI</td>
<td>Schools</td>
<td>13 pages</td>
</tr>
<tr>
<td>SchoolNet: School and District Data I and II</td>
<td>2015</td>
<td>NC DPI</td>
<td>Principals at 2015 training; Schools across the state</td>
<td>12 slides, 24 slides</td>
</tr>
<tr>
<td>SchoolNet: Tools for Principals</td>
<td>2011</td>
<td>SchoolNet</td>
<td>Promotional video for potential customers (schools)</td>
<td>2:54 minutes</td>
</tr>
</tbody>
</table>

Observations

In North Carolina, training for educators is ongoing, organized by the state in regional or district workshops. Given the researcher and university network of DPI contacts, gaining entrance to a day-long series of these trainings was feasible. Accessibility is enhanced due to the non-intrusive nature of the data collection (Adler, P.A. & Adler, P. 1994). The researcher was not a full participant, but documented the phrasing of planners and the meanings (despite the terms) which appear to be attached, as well as the situations where use of the technology is expected. While observing, the researcher was additionally able to note the principals’
reactions and the types of questions they asked. This data contributes to an understanding of how the dashboard technology is expected to affect principal decision making.

Although intended as a non-intrusive observation, the researcher was not hidden. Any interactions with presenters or participants demonstrated an effort on the part of the researcher to respect their work and to establish rapport with them (Merriam, 1988). A basic data collection form which organized the field notes taken during the observations and noted the targeted data collection is included as Appendix L. Based on Merriam’s (1988) suggestions for observations, the data collection form notes the setting, the participants, the presentation and any interactions with the audience. Immediately following the observations, the researcher expanded and completed the field notes. The observation data was kept on the researcher’s personal computer, backed up with a dedicated flash drive, similar to other research materials. As with the documents, observation data were mined for the main purposes of discovering the understandings associated with data technology terminology and the circumstances of expected use: the perspective of the presenters and the questions or concerns expressed by the audience.

The observations were of a full-day training on SchoolNet, the assessment product in the suite of Home Base tools. I observed a half day training designed for school administrators and then joined the remaining sessions designed for teachers, who had been scheduled for a full day of training on July 21, 2015, in Newport, North Carolina. This training was one of eight held around the state in the summer of 2015 and was led jointly by NC DPI and the vendor's Home Base implementation staff. These sessions are outlined in Table 5.
Table 5

*Trainings observed*

<table>
<thead>
<tr>
<th>Session Title</th>
<th>Presenter's Affiliation</th>
<th>Intended Audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>School &amp; District Data: The Power of the Home Page</td>
<td>Digital Teaching &amp; Learning Coach from an area school district</td>
<td>Teachers</td>
</tr>
<tr>
<td>SchoolNet: Assessment Admin Module &amp; Classrooms Module</td>
<td>Pearson (technology vendor)</td>
<td>Administrators</td>
</tr>
<tr>
<td>The North Carolina Educator Evaluation System</td>
<td>NC DPI</td>
<td>Administrators</td>
</tr>
<tr>
<td>School &amp; District Data: Student Performance</td>
<td>Digital Teaching &amp; Learning Coach from an area school district</td>
<td>Teachers</td>
</tr>
<tr>
<td>School &amp; District Data: Reports</td>
<td>NC DPI</td>
<td>Teachers</td>
</tr>
<tr>
<td>Using your Learning Management System with SchoolNet</td>
<td>NC DPI</td>
<td>Teachers</td>
</tr>
</tbody>
</table>

Observations and document analysis functioned as secondary methods in this research. Observers, particularly those working alone, rely heavily on their own perceptions and cannot ensure validity (Adler, P.A. & Adler, P., 1994). As for the examination of documents, which are mute artifacts, research validity is equally difficult to obtain. The researcher also risks interpreting the documents out of context (Hodder, 1994). As complementary techniques to the far more substantial interviews, however, both document
analysis and observations contributed in important albeit limited ways to the results this study produced.

**Data Management**

Procedures followed the outlines given in Stake (1995) and Huberman and Miles (1994). If the participants approved it, the interviews were audio recorded. The raw data was transcribed by the researcher within a week. In addition, the researcher made field notes during and immediately following each interview.

Any hard copies of data were kept in one locked cabinet in the researcher’s home office, with the electronic information on a personal laptop computer used only by the researcher, with a dedicated flash drive for backup storage. Both the laptop and the flash drive are password protected.

**Data Analysis**

This section includes the analytic strategy, specific coding procedures, and the classification of data into categories and themes. Although narrative data may accumulate as principals recount the events leading up to their current status of data-driven decision making, the essential data analysis was synchronic, or issue-focused, as opposed to diachronic, or chronological (Weiss, 1994). The analytic strategy originated from the need to articulate the knowledge, skills, and dispositions of successful principals using data dashboards for making school improvement decisions.

**Developing Codes**

During data collection and the subsequent processing, the researcher noted observations and questions: essentially “holding a conversation with the data” (Merriam, 1988, p. 131). Analysis took place concurrently with the ongoing data collection, allowing
for emerging categories. The iterative fashion of analysis allows for a series of cycles as the researcher discovers, understands, and verifies, sifting through the data as it is collected in order to understand the construct in question (Huberman & Miles, 1994). The constant comparative method, although typical with a grounded theory approach (Creswell, 2007), is also appropriate in this particular study due to the expected nature of developing an understanding of the program process (dashboard use).

A codebook guided the organization of the data. Because a single researcher conducted the interviews and the analysis, the codebook needed only to provide structure and reliability to the ongoing process, as opposed to a format for a team of researchers. Codes developed from the research literature (e.g., for dashboard use: Allio, 2012; Eckerson, 2005; Few, 2013; Galloway, 2010; Huang, Lieu, & Chang, 2012; Kaplan, 2012; Kaplan & Norton, 1992; Velcu-Laitinen & Yigitbasioglu, 2012; for data analysis: Bernhardt, 2004; Datnow & Park, 2009; Huffman & Thomas, 2009; Lasley, 2009; Mandinach & Gummer, 2013; Wayman, Spikes, Volonnino, 2013; and for principal leadership: Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010; Copland, et al., 2009; DuFour & Eaker, 1998; Fullan, 2001; Stoll & Fink, 1989). Codes also emerged from the raw interview data (DeCuir-Gunby, Marshall, & McCulloch, 2011).

Several additional concepts emerged in data collection: a problem-solving mindset present in successful users, the use of data for reporting and external accountability and subsequent impact on internal processes, practical data expertise, and organizational as well as individual characteristics. A brief explanation of each follows. A key aspect of the conceptual framework of this study is the decision making aspect of data dashboard use, and its use for systemic school improvement. Based on that understanding, therefore, and an
understanding of the uniqueness of the data dashboard as a planning tool in K-12, one personal characteristic to tease out from the interview responses was the existence of a problem-solving mindset of a principal who is looking forward; actively seeking avenues for improvement. "Dashboards not only describe what is happening now, but they identify trends that can affect future performance” (Galloway, 2010, p. 43). Therefore the researcher listened carefully to references experts and principals make to trends, planning, and studying data prior to decision making.

An additional element discussed in the research literature is the extensive use of data for reporting and accountability measures (Wayman, et al., 2013). Although accountability measures (for general reporting or to evaluate teachers and schools) were not an intended focus in this study, data from several interview participants prompted a return to Knapp and Feldman (2012) who described successful school leaders as those for whom external accountability demands trigger internal structural and process improvements. External reporting requirements and accountability demands were a recurring theme as anticipated, but also impacted the focus of the study, which was not anticipated. Successful principals do translate external demands into internal improvements.

Given that data dashboards are a revolutionary (in education at any rate) tool for data use, a certain element of data expertise is present in principals more successful in the use of dashboards. Looking for references to technical preparation was not difficult. The more complex codes to create were those representing less tangible personal characteristics. The interview participants are also referred to their environment: situational characteristics of the school or district and the resources they can access. Recognizing the importance of the context, Lehman, Greener, and Simpson (2001) built a readiness model around not only
individual characteristics, but also the organization and the resources available.

Organizational characteristics became a category of data emerging from the interviews.

Categorizing data collected in terms of the individual characteristics of the successful users, the elements of the technology product, and the organization in which the data-base decision making takes place was the initial approach. However, the first interviews, with the industry experts, provided new insights regarding another important category, that of the data. Themes of data quality, and data being a fit for the task, emerged in these interviews. A return to the literature in light of these emerging themes helped clarify the focus of this study on the characteristics of successful principals accessing data via a technology product in the context of their organization.

Finally, the pioneers of data dashboards for school decision making (in this study, industry experts and experienced principals) probably did not have the luxury of a needs assessment prior to their own introduction to the use of the tool for their school planning. Nevertheless, they had opinions as to the needs of their colleagues who have yet to leverage a dashboard tool for improved data-based decision making. Simply asking these leaders what knowledge, skills, or dispositions they deem essential for principals to use data dashboards may elicit information to complement or corroborate the themes emerging from their previous responses. It was also important to draw out anti-examples, both of personal qualities and of professional development offerings. The experience of a practitioner using a Home Base-like dashboard can help other districts avoid spending precious resources on superfluous professional development.

This data collection section concludes with a discussion of ongoing documentation of research understanding. The researcher made regular memos, and also kept a researcher log
to track development of concepts and code refinement (Merriam, 1988). There was not be a particular form used for the field notes. However, processing these notes (Huberman & Miles, 1994) by extending, editing, and transcribing them into an electronic format within a day of the interview captured the researcher’s memories of the interaction, and supplemented the transcription of the recorded interview.

**Systematically Classifying the Data**

Merriam (1988) discussed the process of “thinking about one’s data” (p. 140). The data analysis of this study follows a systematic process of classifying data into categories and themes, thus “moving from concrete description of observable data to a somewhat more abstract level ... [of] using concepts to describe phenomena” (Merriam, 1988, p. 140). Although the literature has guidance for possible codes, as detailed in the section above, data analysis essentially consisted of open coding. The coding process was conducted with the qualitative data analysis software Atlas.ti (Scientific Software Development, 2013, Version 7).

Because the researcher personally transcribed the interviews before uploading to the data analysis software, the transcripts were quite familiar before the coding process began. The first iteration of coding consisted of coding major themes. The second iteration confirmed the major themes and identified sub-themes. The codes were organized according to the major, overarching, themes and the associated sub-themes. As the codes were refined, they were evaluated to ascertain the level of meaning and whether they are weighted similarly. Code evolutions and coding process iterations were documented in the researcher log.
In the complexity of the day-to-day demands on a principal, there may be many explanations for what principals express about the data dashboard use. Researcher familiarity with the school context was useful as the transcripts were analyzed for alternative explanations for any tentatively drawn conclusions.

**Validity and Reliability**

In this section, an overarching philosophy of quality assurance is explained, and then the practical steps of ensuring quality are discussed. Knowledge in this study is viewed to accumulate through interactions with experienced and well-placed sources. The understandings evolved and were subject to revision as the body of research took shape; this nature of knowledge can be described as constructivism (Guba & Lincoln, 1994). Two sets of criteria guide constructivist judgment of the quality of inquiry: trustworthiness and authenticity (Guba & Lincoln, 1994). Trustworthiness in qualitative work can be discussed in the manner that internal validity would be discussed in a traditional positivist paradigm, and authenticity could be said to replace the term external validity in the same way (Denzin & Lincoln, 1994). A brief discussion of each criteria lends credence to the validity of this qualitative research study.

Denzin (1994) noted several strategies which increase credibility, an aspect of trustworthiness. Repeated and prolonged engagement with the data sources in the field, persistent observation, and triangulation are among the strategies which were employed in this study. Authenticity allows consumers of the research, in reading the presentation of data, to be drawn into the subjects’ worlds. If the “written accounts contain a high degree of internal coherence, plausibility, and correspondence to what readers recognize from their own experiences and from other realistic and factual texts” (Adler, P.A. & Adler, P., 1994, p.
381) then the research is authentic, and can be judged to have a high degree of external validity. Articulation of the theory of change as an outcome of this study further provides a certain generalizability. As program planners understand “the essential levers” (Weiss, 1997a, p. 511) which effect change in a given program, they can better determine the potential fit of the program to their own situation.

Triangulation of data sources and multiple perspectives of theory (Denzin, 1978, as cited in Janesick, 1994), and interdisciplinary triangulation (Janesick, 1994) ensured dependability, or reliability of the results. The interview data was corroborated by observational and document analysis. Multiple perspectives of theory also provide dependability. First, the Cousins and Leithwood research (1993) which investigated the use of information for school improvement established an overall conceptual framework. Their discussion of knowledge utilization provided concrete meaning to terms used in this study (such as data-based decision making), often bandied about to the extent that the term conveys little. Second, tangible constructs such as organizational routines (Spillane, 2012) also brought vague notions firmly to ground and thus led to solid conclusions. Finally, the domain of program evaluation also provided theoretical constructs which structure processes and add clarity. In this way, triangulation both of data sources and theory contributed to the dependability of this research.

To further ensure dependability, the interdisciplinary approach of this research establishes a more detailed and thorough understanding of the technology. The use of data technology in education has been slower to mature than in other domains (Bienkowski, et al., 2012). Exploring major influences in other fields, such as the Balanced Scorecard of Kaplan
and Norton (1992) or Few’s dashboard design critiques (2013) established the development of data technology more clearly and reliably than a review of educational data research alone.

In terms of practical methodological design, certain habits provide transparency and should mitigate quality concerns (Marshall & Rossman, 2006). Throughout the process of interviewing, the researcher made memos to document the evolution of the themes. As an example of the researcher’s self-analysis, engagement with “the value judgments and personal perspectives that are inherent in data collection and in analysis” (Marshall & Rossman, 2006, p. 206) constantly permeated the interviews, transcriptions, field observations, and analysis.

One of the limitations of this study, addressed in the first chapter, is that the political context (Leeuw, 2003; Weiss, 1995) of the North Carolina technology may complicate efforts to understand the theory of the program, or the dashboard. Another concern raised was that gathering data from program stakeholders can lead to data colored by personal or professional motivations (Taut, et al., 2010). Being aware of these dynamics prior to interviews increased the researcher’s ability to sift through the data in a more nuanced manner.

A guiding principle throughout the qualitative portion of this study is that this research “falls within the context of discovery rather than verification” (Ambert, et al., 1995). While theory guided the direction of the research (including the initial interview questions and the planned data analysis), there were no preconceived ideas to be verified; this was an exploratory study. The respondents described their own reality (Rubin & Rubin, 2012). Despite the researcher’s background as a teacher, the interviews focused on the school level and the researcher guarded against imposing a classroom or teacher perspective on the data.
This study targets principals and their ability or willingness to improve their schools with information from the data presented to them via the dashboard.

Summary

This study employed qualitative research methods and collected data for a theory-based evaluation (Weiss, 1997a) in order to explain how data technology tools impact decision making. A basic interpretive qualitative design (Denzin & Lincoln, 1994; Merriam, 2002) was first used to outline the nature of dashboard use according to experts in industries where dashboards have a longer history and a more robust data technology literature base than in education. Then, with a case study design (Creswell, 2007; Merriam, 1988; Stake, 1995) and a focus on a data dashboard implementation in North Carolina, this study elicited program theory from North Carolina stakeholders. The bulk of the data collection consisted of interviews: industry experts, practicing principals, and North Carolina Home Base planners and vendor experts. Document analysis and observations complemented the interview data. Data were managed with the help of the qualitative software Atlas.ti (Scientific Software Development, 2013, Version 7). Analysis consisted of coding, starting with codes suggested by the literature while allowing for additional codes to emerge. The next chapter presents the findings from the research and the final chapter discusses conclusions about the knowledge, skills, and dispositions of principals who effectively use data dashboards.
FINDINGS

This study seeks to identify the knowledge, skills, and dispositions contributing to principals' successful use of data dashboards for systemic school improvement. Data sources included the theoretical and empirical literature related to dashboard use in domains outside education, interviews with industry experts, as well as interviews with North Carolina policy makers, technology vendors, and educators. Complementing these sources were observations and document analysis associated with the implementation of Home Base in North Carolina. In this chapter, the findings of the research are presented.

The chapter begins with a review of the purpose and methodology of the study and continues with a brief overview of the data sources, as well as data management and analysis strategies. The description of the findings begins first with data from the industry experts and a logic model of dashboard use based on business literature and interview data. Next, the North Carolina case study findings are described, both those data sources which are connected to Home Base technology and those which are not. The two models depict first, the ideal or intended use of dashboard technology; and second, the reality of dashboard use in education. The chapter concludes with a brief discussion of the findings and an overview of the final chapter.

**Review of the Purpose and Methodology of the Study**

The purpose of this study was to identify the knowledge, skills, and dispositions contributing to successful use of data dashboards by K-12 principals for systemic school improvement. To accomplish this purpose, I opted to present the findings as a theory of change, and in particular, as a logic model. The theory of change which underlies the connection between accessing data via a dashboard and principals’ use of data sheds light on
what is needed for principals to carry out effective decision making. Specifically, to offer
effective professional development for principals, school leaders need to understand the
mechanisms of a person's interaction with data, as well as with the technology which
provides access to that data. By expanding our understanding of how dashboards can change
data-informed decision making, and specifically how schools in North Carolina are
implementing the Home Base technology, this study will inform more effective principal
professional development related to dashboard use. Further, not only will school
improvement efforts in North Carolina that rely heavily on data use benefit from the results
and recommendations of this study, other states will profit from North Carolina's experiences
as they develop and refine their own data technology infrastructure.

A theory of change can be effectively depicted via a logic model. These types of
models articulate the functioning of a program: illustrating the input which leads to activity
and intended output (e.g., information about participation in the activity) and ultimately to
desired outcomes. The desired outcome for dashboards is echoed in North Carolina's
Summary Information Technology Plan. One objective of Home Base, for example, is to:
"Collect, organize, analyze, and report data to provide information useful for decision
making" (Price, 2012, p. 5). This study attempts to explain how that decision making will
improve, for principals, given the data technology provided.

In Figure 12 below, the impact on the far right corresponds to improved decision
making, and in education, increased student achievement. Models in this study will focus on
the following categories of the logic model: Input, Activity, Output, and Outcomes. More
specifically, in terms of input, the focus of this study is the knowledge, skills, and disposition
of the principal. Other resources (input) exist, and are examined to the extent that they influence or shed light on the necessary knowledge, skills, and disposition of the principal.

![Diagram of Input, Activity, Output, Outcomes, and Impact]

*Figure 12. Generic logic model demonstrating a theory of change.*

In this study, a theory of change specific to North Carolina emerged following observations of Home Base training, analysis of official Home Base documents, and interviews with vendors, state planners, and users. The case study portion of this research served as an illustration of the alignment between the theory of change, the program it describes, and the context in which it will operate (cf. Rossi, Lipsey, & Freeman, 2004).

**Data Collection and Analysis**

Interview participants ranged from experts in technology from domains other than education (Phase 1) to educators (Phase 2). Educators included school-based staff and district or state personnel. The titles for the participants listed in the previous chapter's explanation of data sources are clarified again prior to the description of the findings for each phase in this chapter.

Effective data-based decision making requires a complex blend of knowledge, skills, and disposition. Due to the complexity of the research question, and the exploratory nature of a study focused on data technology in education, a scripted and structured interview would not have been productive. The interview questions were carefully planned, and the researcher took a copy of the protocol to each interview. However, the interview was a semi-structured one designed to allow for individualized follow-up questions in a style described by Rubin.

As a final data source, complementing the observations in Phase 2, document analysis provided an understanding of terminology used in North Carolina and shed light on the intentions for the Home Base suite of products. The documents consisted of an officially released technology plan for the state of North Carolina, training materials and presentations, and a marketing video for SchoolNet, all documents in the sense of public records (Hodder, 1994). Two sets of presentation materials from the SchoolNet training observed by the researcher in July 2015 are included in the document analysis. Hodder (1994) discussed the risk of interpreting documents out of context; attending the training where the materials were used mitigates this risk for those documents. All documents are publicly available online.

The researcher personally transcribed the interviews and then uploaded transcripts, observation notes, and documents to the qualitative data analysis software ATLAS.ti (Scientific Software Development, 2013, Version 7). Hard copies of data, including the audio recordings, have been kept in a locked cabinet in the researcher’s home office. Electronic information has been kept on a personal laptop computer used only by the researcher, with a dedicated flash drive for backup storage. Both the laptop and the flash drive are password protected.

During the transcription process possible themes and questions suggested by the data were recorded in the researcher log. Thus, the subsequent coding stages flowed quickly and smoothly. Codebooks for Phase 1 and for Phase 2 (Appendices M and N) document the codes with a definition and an example for each code. Throughout data analysis, the researcher returned in a circular fashion to the raw data and to the literature (DeCuir-Gunby,
Marshall, & McCulloch, 2011) to examine the research basis for themes emerging in interview data.

Research Question

The following question guided this study:

What knowledge, skills, and dispositions contribute to effective principal use of data dashboards to inform systemic school improvement?

Knowledge is defined as knowledge of educational pedagogy and an awareness of technology capabilities, as well as an understanding of the links between the two (Militello & Ersozlu, 2013). Skills include finding meaning in data, manipulating spreadsheets, budgeting, and managing district and state resources. Knowledge and skills for interview participants outside education are conceptualized similarly, substituting knowledge of their domain for educational pedagogy, for example. Disposition means an attitude or mood, or the tendency to act or think in a certain way (http://www.merriam-webster.com).

Although the focus of this study remains people—users of data technology—the theory of change for dashboard use cannot be fully explicated without an understanding of the technology product which facilitates access to data, and the context of the organization in which it all takes place. Data use must be considered from the perspective of practice (Spillane, 2012). These factors interact as the program (the dashboard) meets the target (the dashboard user) as shown in Figure 13.
No matter the work environment, people work with data for decision making through the vehicle of a data technology product in the context of an organization.

**Description of Findings**

The presentation of the data is divided into Phase 1 (dashboards in domains other than education) and Phase 2 (dashboards in education). By presenting the complexity of the context, and ample direct quotations, the researcher endeavors to present readers with a nuanced depiction of the lived experience (Denzin, 1994) of both experienced dashboard users (Phase 1) and educators' dashboard use in the face of changing data technology (Phase 2).

**Data Dashboards Outside Education (Phase 1)**

This section first presents and briefly explains the logic model which functions as an overview to the section, then introduces the interview participants, and finally presents the findings. Figure 14 below models the input (people, product, data, and organization) in this phase and serves as an outline of the findings to orient the reader. Also in the model, the outcome is phrased as analytics, which is how Phase 1 participants view the interaction with the data.
the program (the dashboard). Findings related to the input, the activity of the program, the interaction of the elements of the program, and the outcome (analytics) are presented in this section.

Figure 14. Model of effective dashboard use based on Phase 1 interviews.

People are the users of technology products, and it is their knowledge, skills, and dispositions which are the focus of the study. Nonetheless, the product, the data, and the organization all influence how people successfully make data-based decisions. The nature of the product and the status of a product implementation impact the use of the technology. In addition, data become a focus as users are increasingly faced not with a lack of data, but with an overwhelming volume of data, and not always in the format desired. An additional important input is the organization itself. An organization's strategy must structure the
content of a data dashboard for it to be an effective tool, and only an organization's quality business processes will ensure successful implementation of decisions made.

The interview participants come from four different companies and are referred to by their titles. The Senior Account Executive and the Senior Manager come from one large company known as a business analytics firm. The Senior Account Executive works in the domain of state and local government and the Senior Manager in higher education services. The Chief Analytics Officer works in healthcare at a large management consulting firm. The Business Advisor works for a mid-sized healthcare information technology company, and the Web Development Manager works for a nonprofit serving higher education. The findings in this section begin with a focus on people (their knowledge, skills, and dispositions) and conclude with the technology product, the data, and the organization in which the activity takes place.

People. The five corporate experts interviewed all highlighted disposition as an important consideration; however, knowledge and skills to the extent that they were referenced are included here. The theme of analytics—as a mindset—was key in the interviews and is presented here. Findings related to the factors of knowledge, skills, and dispositions, as well as brief discussions of how they overlap, are presented in this section.

Knowledge and skills. These five users seemed nonplussed when asked about knowledge for successful use of a dashboard. "If I’m looking at a dashboard that was created by some sort of decision support vendor, say ***** or ***** or us, then yeah, I expect some sort of basic training on it, but what I know about dashboards didn’t come from any vendor, or any training" (Chief Analytics Officer). The lack of focus on knowledge or skills (related specifically to dashboard use) may in part be due to emerging technologies familiar to these
experts which make data access more intuitive. The Senior Account Executive views new visual analytics tools as more user-friendly and more DIY [Do It Yourself]. Traditional business intelligence tools (he offered several examples) tend to be very tech heavy and may need a tech team to manage.

The company where this Senior Account Executive works is known for its data visualization. In this interview, however, he pointed out innovations which even within his own company are revolutionizing data visualization. His firm's core business is providing visualization to its clients, and he noted that their products are "prepared for a wide range of skill sets. So, lay out is basic, direct. Information for each report is available. A lot of effort goes into the text below." The Senior Manager works at the same company, and discussed how he introduces clients to the technology:

So we've seen that to be successful in that is to take an incremental approach. Don't give me everything. Don't try to boil the ocean. Give me something and let me show value in that. Let me reveal a nugget of information. Let that be the catalyst that drives—a little bit more, a little bit more. Over time, you can build it. Where if you throw them everything at once, it's overwhelming. (*Senior Manager*)

These references to training were supplemented by references to analytical skills:

Otherwise, it’s just pointing to something and saying this is broken. That doesn’t do anyone any good. And that, from what I see, has always been a problem. There are a lot of people who are really good about pointing out where something is broken, but they lack the analytical skills to say this is why it’s broken. (*Business Advisor*)
Analytics surfaced as a theme in these interviews both as a set of skills essential to successful dashboard use and as a mindset (discussed in the next section). Analytics link data access and appropriate action.

**Dispositions.** In this section, successful users are described in terms of their mindset or attitude. The disposition of the user is closely related to the role a user is assigned (leader versus manager) and is also related to knowledge possessed by the user (intuition is a quality resulting from domain expertise). All interview participants spoke about analytics, which is defined as a method of logical analysis (http://www.merriam-webster.com/). The voices of these industry experts offer some tangible ways analytics connects data and action.

One participant expressed strong opinions about leaders versus managers and how both roles require data, but in different ways. "Managers are great at keeping up the status quo. Leaders are really good at saying, ok, this isn't working. We need to come up with a new way to deal with it" (*Business Advisor*). Managers may need quick access; perhaps a graphical representation of information. Leaders need to be able to look from a high level but also follow their insights to the detail in order to create meaningful action. The Business Advisor sees the distinction between leaders and managers as an aspect of an employee's disposition, although others may interpret that distinction as due to an employee's role in the organization.

Another participant described the distinction between leaders and managers in terms of a quality: being task-oriented. "Some folks will be like, 'why do we even—I just want to get to my work, I don't know why you are showing me these pictures. Or, when I log in here, I have a specific thing I want to do.' They're very task-oriented, possibly. They want to get to
the task” (Web Development Manager). This theme refers to individuals less willing to engage in big-picture data; those who simply seek specific information to accomplish a task.

The Senior Manager spoke at length as he contrasted *I think* versus *the data show*, seeking to distinguish between opinion and evidence, and yet he ultimately emphasized the importance of intuition. In the Senior Manager's role at his company, he works with state government staff who have expertise in transportation or criminal justice, for example. The Senior Manager discusses how the data augment industry knowledge, which he describes here as intuition.

Whether it's people going to talk to the legislature, whether it's somebody from DOT that's having to go present some information to the legislature. What a better way to go to them [the legislature] and say, we did some research, and here's what the data reveal. Now, based upon that, either I think or I feel—this is the decision that we should make. ... Here is what the data history has shown, what analytics have shown. And then, with my intuition, how you apply those, how you add those together, to make the right decision. (Senior Manager)

*Analytics as an operational mindset.* Analytics figured prominently throughout the discussions. These interview participants guide their inexperienced user clients if those clients omit the step between access to data and action by thinking that data drive action directly. For example, the Chief Analytics Officer notes:

The numbers are going to do one of three things. They're either going to go up, go down, or stay the same. That doesn't tell me anything. Maybe they changed significantly. That still doesn't tell me anything, other than that they went up or down
significantly. Doesn't tell you why. You need to have some framework for doing that.

(Chief Analytics Officer)

Another way these participants view analytics is as a contrast between historical data reporting and analysis. One participant describes the variety of needs expressed by his clients:

Are they just at the point, maybe early on, where they say, 'I just want to look at the historical information that I have'? or [do they want to] just look at trends? Or are they advancing along where they now want to take advantage of some of the technology where they're really looking at applying analytic prowess?" (Senior Manager)

When describing this company's work with one of its current clients, a higher education institution in another state, the Senior Account Executive notes: "What's problematic? The mindset of producing reports instead of analysis." He listed three tasks the company performs on behalf of their clients: (1) data management, (2) predictive analysis, and (3) reporting and modeling, thus highlighting the importance not just of data access, but also data analysis.

The theme of analytics surfaced also as a function of interacting with the data. Participants from two different companies referred to this function as asking questions of the data. These participants both work with their clients to make use of a technology product. The clients must consider: "What do you want to ask? What question are you trying to ask of the data? Is there a story you are trying to tell? Who is your audience? What questions are you trying to answer?" (Senior Account Executive) The link between data access and meaningful action is expressed in two steps by another industry expert, who helps his clients
with these questions: "1. What to look for in their data, and 2. What to do with what they find" (*Business Advisor*).

Much of what these participants articulated about analytics relates to *why*. The Chief Analytics Officer emphasized that raw data "doesn't tell you why". The Business Advisor discussed the limitations of simply knowing that something is broken. Analytics help you understand "why it's broken". The Senior Account Executive discusses the questions he helps his clients ask: "1) What happened? 2) Why did it happen? 3) What will happen? How do we optimize our actions based on our limited resources?" Data access is only the tip of the iceberg; analytics leads to meaningful action.

**Product.** The Phase 1 participants, expert users or designers of the product (dashboard technology), emphasized the need for a drill-down capability. Without this capability the end user cannot confidently take action. "[If] I can't get to the root cause, at the end of the day, operationally, as an executive, I need something to act on. I need to know that what I'm acting on is the right thing, at the right time, in the right place" (*Chief Analytics Officer*). This same participant discussed the importance of being able to go off-path, to follow unexpected insights. "Here's where I see a pattern, here's where I see an outlier, here's where I see an opportunity. What if this changes? What is the root cause of this?" (*Chief Analytics Officer*) Allowing the end user to follow insights to an actionable point is a function of a tool which supports analytics. Participants also recognized the importance of visualization as presented in the literature:

I've seen those aha moments quite a bit. Whether you're doing something on the visualization side or on the data management side, or you are looking at their data, and they're giving you an immediate look, like, can you go back to that? And then
they start seeing some things, and Wow! They just didn't realize there was some nugget of information out there, that they didn't know about. (Senior Manager)

Participants also referenced the dashboard as a means of communication, both horizontally in the organization or in the case of this user, vertically:

   It can become a good communication tool as well. They can take a snapshot of this, give the boss access to it, and say, look, this is it, reading right from the raw data.

   That gives you visibility into the process. (Web Development Manager)

These industry experts link the technical design of the product to the user's ability to make decisions and take action.

   **Data.** Are the data a fit for the task? What do the data mean? Users inexperienced with data access do not always respect the significance of data quality, and tend to shift their attention away from data and directly to the product they then expect to serve as a decision-making tool. The importance of data formatting is emphasized by this participant:

   Somebody can just give you data and the data may be clean. They might have gone through their vetting process and the data are accurate. But is it in the right format that you want to be able to do the analysis you want? So someone says, "I want to be able to drill down from year to month, to week, to day, to hour." Well, are your data set up that way? You might have a date field in there, but it might not be set up in the right way to allow you to drill down in a visualization tool. (Senior Manager)

   **Organization.** Individual employees work in the context of an organization which is responsible for overarching strategy and key performance indicators (KPIs), or metrics.

Questions an organization should answer are described as follows:
What are the data that drive the business? What are the metrics that drive the business? Who owns those metrics? How are they defined? Where are the data coming from? ....

To me, the metrics are just like knowing what time of day it is. It’s a data point, not an end result. (Chief Analytics Officer)

Another organizational task is holding employees accountable in a way which leads to furthering the organization's goals. Depersonalizing accountability is a benefit organizations can leverage when working with individual employees, according to one participant, who discussed the national quality standards in the domain of healthcare.

That’s how we get credibility. You know, 'don’t come in and tell me how to do my job'? ... This is a gold standard, and it’s widely accepted. How do we get toward this gold standard? When you have that conversation, I’m not saying that you’re doing a bad job; I’m saying that the gold standard is here, here's where the organization is, and here’s where your performance is. We need your organization to get to the gold standard and we need your help getting there. It’s a different conversation. (Business Advisor)

Organizations also establish the roles of employees who will take action. "It's important to empower the end user to make changes" (Business Advisor). Finally, organizations with successful dashboard use have a means for taking effective action. Business processes are in place for action steps. Outputs are measured (is the mitigation plan implemented?) as are subsequent outcomes.

I think what happens frequently is that, well, a dead-end will be hit and people throw their arms up and say, "I tried." There's no mitigation plan. If we've done one thing
and it's not working, well, what else can we do? What is the escalation process? And then that needs to be tracked. *(Business Advisor)*

The Chief Analytics Officer discussed engineer and statistician W. Edwards Deming, referring to "statistical process control" as a way of framing data use to improve business processes. Successful organizations, therefore, have processes in place to facilitate the action resulting from data-based decision making.

**Phase 1 findings: conclusion.** The research question guiding this study focuses on people: their knowledge, skills, and dispositions. These people interact with a product which facilitates access to data in the context of their organization. This interaction leads to problem solvers engaging with their data, asking questions of their data, thinking about their data; another word for this activity is analytics. People seeking analysis need capacity in their data technology for drilling down to actionable data points. They also benefit from a flexible product which allows them to follow insights which may not occur in a linear fashion (going off path). Their data must be fit for the task of visualization, and the volume of data can be managed with visualization. Finally, successful organizations articulate quality standards well, align them with the dashboard, and provide as well clear business processes for the action resulting from data-based decisions.

**Data Dashboards in Education (Phase 2)**

This section presents models of dashboard outcomes both as experienced by users currently and as ideally envisioned, and then offers findings based on interview data. These findings emerge from interviews with thirteen participants, as well as observation and document data. First, an explanation of terminology is presented, followed by a summary of North Carolina's technology products. Next, the models of dashboard outcomes provide an
overview of Phase 2 findings. Then, responses from data technology users in public schools are presented. Finally, results specific to North Carolina's technology adoption are presented as a case study and an opportunity to examine the intended use of dashboards for improved data-based decision making.

*Analytics* is a common term in business. In education, practitioners are far less likely to use this term, yet the need for and examples of analytical thinking are expressed. In the North Carolina Home Base context, NC DPI and the technology vendor often refer to *reporting*, and so do users. Reporting is required for many school accountability purposes (reporting to the district, state, or federal government); yet in the context of Home Base, and specifically in the SchoolNet product within Home Base, reporting refers to analyses. The overlap of these terms and subsequent implications are explained later in this section.

**Review of technology products.** Home Base is the North Carolina-specific term for the suite of technology products. It is *Home Base* which is examined in the case study portion of this research as a possible dashboard. The products which make up Home Base are often identified by users individually, as is described more fully in a later section. *Power School* is the Student Information System (SIS) with the student data which powers the other applications. *SchoolNet* is the Instructional Improvement System (IIS) which houses the assessments, data analysis, and resources for instruction. At this time in North Carolina, SchoolNet is used exclusively for assessment data. Certain products included in Home Base are not addressed in this study because they are either not directly relevant to the research question (e.g. the North Carolina Educator Effectiveness System, or NCEES) or because they are not a current focus of North Carolina training or use (e.g. OpenClass, a collaborative environment for student work). Other important technology products familiar to North
Carolina educators still perform core functions. The Education Value-Added Assessment System (EVAAS), a SAS product, predicts student performance and provides information for teacher and school evaluations. Still other products support schools and NC DPI in less direct ways. Home Base and the other products are explained in the Summary Information Technology Plan (Price, 2012).

**Models.** This section offers a partial model of the dashboard as a program which aligns with the current reality in practice in North Carolina, and additionally offers a variation on that model based on ideal use as depicted more generally in Home Base documentation. Comparing the theory of change demonstrated by the technology in practice with the intended theory of change will help educators clarify their expectations of dashboards, and perhaps provide more vision of the potential for dashboard use which is otherwise not well known in education.

In Figure 15 below, the central output consists of people interacting with a product (in this case, Home Base) which gives them access to data in the context of an organization (their school). A key difference between reality and ideal use surfaces in the outcome. Note that despite high level references in North Carolina's public documents to improved administrative decision making, the primary outcome in reality is expected to be instructional improvement. In Figure 16, the same central activity is connected to a depiction of ideal outcome which is derived from high level references in Home Base documents as well as from principal literature such as Bryk, et al. (2010).
The goal of this research is to articulate the knowledge, skills, and dispositions of principals who successfully use dashboards for school improvement. Findings are first organized by these three categories: knowledge, skills, and dispositions. To orient the reader,
Figure 17 below lists these findings in the form of inputs in a logic model. In pursuit of the research goal, this study outlines the theory of change which underlies dashboards so that specific steps toward successful use become more clear. Thus, findings related to the product (Home Base in North Carolina), the data, and the organization are also presented, as a means to more fully presenting successful dashboard use. The full models and more discussion are presented in the next chapter.

**Figure 17.** Model of Phase 2 findings.
People. The seven school-based participants were from six different public school districts in North Carolina. These participants include a curriculum specialist, an assistant principal, and five principals. Two principals are at elementary schools (Elementary Principal A and Elementary Principal B), one is at a middle school, and two are at high schools (High School Principal A and High School Principal B). The other six Phase 2 participants include three district-based staff (one retired) from three districts; none of these districts overlap with the districts of the school-based participants. The final Phase 2 participants are two NC DPI staff and an employee of the technology vendor. I refer to these other Phase 2 participants by their roles. Note that for the NC DPI staff, the precise role title would be too distinctive. These participants are referred to as NC DPI Presenter and NC DPI Staff. Those participants designated as SchoolNet users include the Home Base DPI staff and the technology vendor, the curriculum specialist, the director of testing and student information, and two principals; the latter four participants represent three North Carolina school districts which have committed to the optional Home Base suite of products. At this time, SchoolNet is the key product distinguishing educators in districts which only use required products from those in districts which have opted to purchase the entire suite.

The range of interview participants were purposefully chosen because they are well placed to offer insights toward an answer to the key question regarding characteristics of successful principals using dashboards. The need for targeted principal research attention emerged also in the interviews; NC DPI Staff stated that "principals are huge stakeholders" and that DPI "hasn't been in front of them enough". Asking, "how do we reach them in a way that impacts the school building?" NC DPI Staff acknowledged the key role played by the
principal in the school as a whole, and thus that principal knowledge, skills, and dispositions matter. This section will describe the findings related to those important characteristics.

**Knowledge.** Assessment as a theme was pervasive; findings in the skills section address assessment. Awareness of data technology did not emerge as a theme. Non SchoolNet users were not aware of SchoolNet at all; did not recognize even the name or that such an analytical product was available. SchoolNet "users" were not well versed in it themselves, as it is still relatively new to them. NC DPI Staff, the technology vendor, and presenters at the SchoolNet training were naturally familiar with SchoolNet. Findings related to participants' awareness or lack of awareness are therefore not included. The technology vendor, a former principal, plays a role on the Home Base Implementation Team as a content area specialist for SchoolNet. Her insights are presented here, followed by findings related to professional development desired by school staff, which, when articulated, tended to be specific to the technology tool and how to use it for data access.

**Principal knowledge.** The technology vendor articulated the content knowledge specifically necessary for principals, contrasting data knowledge with general principal knowledge. Her hypothesis is that younger principals understand how to access data but not how to take action, while seasoned principals understand how to take action but not how to access data. She expresses this hypothesis as follows:

I said this just today: Younger admins can get it. They know how to work a scenario that gets them information. They don't know what to do with it. I mean they don't know what kind of decisions to make with it. They don't know what their decision options are. They haven't had to do it. ...
More seasoned administrators can't get it. They have to wait for somebody to put it in their hands. Then when they get it, they know where to go. I know to spend this amount of money in October. I know to hold money for January ... I know to spend my April - June money on this date ... They know the series of how to be successful. They don't know how to get, what to use to get to it. They've been super-dependent on the district to do it. Somewhere you got to marry that. You've got to be a getter and someone who knows what to do. I don't think it exists right now. *(Technology Vendor)*

As a former principal now representing Home Base across the state, the technology vendor is uniquely placed to offer this commentary regarding principal knowledge. Her comments illustrate the combined needs for data access and decision making based on data.

*Training desired.* The idea of knowledge as a theme is perhaps notable by its absence. However, practitioners may not know how to express conceptual knowledge needed, even if they themselves possess it. The curriculum specialist was not confident that educators can be trained for effective data-based decision making. "Until you are in the situation, it's so different among all the schools. I just think it's just something you've got to learn along the way" *(Curriculum Specialist).* Educators do think that lack of time is an obstacle, and they find that an overall sense of possibilities can be motivating. "I think it would do more for them if they had the time, if there was more training on 'now, here are some other ways to use it'" *(Elementary Principal A describing training she would like for her staff).*

When asked about training or desired support systems, participants did offer input, which is presented here as a means to examine their perhaps unarticulated sense of necessary knowledge. Many of the responses related to training (both from school-based staff and non
school-based staff) addressed the functionality of the technology rather data-based decision making or principal action. "I think you first have to show them what's available, and the functionality" (Technology Vendor).

We log in to Power School now to use the evaluation system. That's a portal for that. There's lots of things you can do with it, but it's also like knowing... every once in a while I'll pick up something from my data manager that has ... If you hit like, +Control F, you can search by last name or something. (Elementary Assistant Principal, referring to Power School when she meant Home Base)

Professional development in one Home Base district is described by this participant:

This year, it's been requested that I do a PowerPoint Schoolnet session. It's open so if they want to come they can. If they don't want to come, we're not going to force them. I've got 3 sessions every day, down in the lab. It'll be hands-on. It's going to be a hands-on 'what do you want to know?' Now what I like to do is I like to take the first 15 minutes and I like to go ... if you don't know, this is where you go to do this or that. I would take them what I showed you: the quick look up, the demographics, the test results. (Director of Testing and Student Information)

**Skills.** Three topics emerged most consistently. In the SchoolNet training, interviews with school staff, and Home Base documents, assessment skills loomed large. References to spreadsheet skills were less overt but more prevalent across the spectrum of all participants. In addition to assessment and spreadsheet skills, a third theme was whether or not it is reasonable to expect the principal to be sufficiently skilled to function as the school's data analyst.
Assessment skills. When data consist nearly exclusively of testing information, an understanding of statistical concepts related to assessment contributes heavily to effective use of that data. Assessment data are the most clearly identified focus of the data technology tools in North Carolina, as noted in official documentation:

   SchoolNet will support the tracking of student activities and assessments directly linked to standards, benchmarks, and/or objectives. Assessments (student tests) or assignments may be linked to instruction and will feature either manual scoring or online delivery and automatic scoring. Based on student assessment results, teachers will be able to use the application to identify and assign instructional material to students that specifically addresses the weaknesses uncovered by the assessment.

   (Summary Information Technology Plan, p. 14)

   During training sessions for SchoolNet users, the essential elements of assessment (such as item analysis) were a key component of presentations. Most discussion centered around SchoolNet for benchmark or formative assessments. SchoolNet training resembled Assessment 101 (standard deviation, percentiles, etc.) as presenters walked attendees through the SchoolNet landing page.

   In addition, one interview participant in this study demonstrated SchoolNet to the researcher, pointing out the historical assessment information, how tests are categorized, and the practical details regarding analysis of results. "So that's the item analysis, and that's huge. If someone were to ask me, what is the most important thing that a teacher should look at? Definitely look at the item analysis" (Director of Testing and Student Information). Another participant expressed concern about the quality of the assessments providing the data.
One of the things that education doesn't do for K-12 is teach somebody how to write a good assessment question.

Interviewer Response: And it's hard!

Yes! Yes, it is. If you're using a faulty instrument for your assessment, then the results of the assessment don't align with what your instinct, your gut tells you about the student, what do you attribute the problem to?

Interviewer Response: You attribute it to the student - and mistakenly so.

Right. You're assessing on the bad device that you've devised yourselves, or pulled up from some test vendor. Then you point ... you misattribute the problem. (Research Specialist)

Spreadsheets. The SchoolNet technology relies heavily on users' ability to export data to Microsoft Excel in order to be able to manipulate the data. Although users can run a variety of pre-formatted reports, or create their own, the true flexibility resides in exporting data and using Excel. In this section, findings related to SchoolNet users of data in spreadsheets, as well as spreadsheet skills in general are presented. Excel, a Microsoft Office spreadsheet tool, is used synonymously here with the concept of spreadsheet. First, key instructions from SchoolNet demonstrate the central role of Excel:

Choose and run a report:

○ Create a PDF of your report

○ Export to Excel

(SchoolNet Training PowerPoint)

Presenters at the workshop who showed participants how to use SchoolNet assumed users were familiar with Excel. During the workshop training sessions, the presenter pointed out
the export button, recommending that users export each class section to Excel, then merge to look at all the students together.

The need for spreadsheet skills in North Carolina at this time is tied to the functioning of the new data technology. Evidence of the Excel connection was clear in the training materials and presenter perspective as well as in participant voices.

Interview Question: What about the school as a whole? Say the principal is trying to understand the 9th graders, or the math department, can he or she come back out and look at teachers side-by-side?

Not grade-wise. They are a lot of exports that you can do ... and pull it out into Excel and manipulate it all you want. That's what I've told them. You can go to historical grades and do an export of your... let's say you're wanting to look at 3rd nine weeks. Just export the 3rd nine weeks' grades. You've got all your students, and it tells you who the teacher is ... You can sort them, you can filter them. ...

Right now you have to export it. You have to know what test you're looking for, or it brings out everything. To me, I'm like, ok, well bring out everything. I can filter what I need. (Director of Testing and Student Information)

Participants described the advantages of using spreadsheets in general. "Maybe if there were ... sometimes the reports just come in a PDF, so the reports are just like .... The report is dead. If the report were coming in a sortable, filterable format, that would increase the closeness" (Elementary Assistant Principal, discussing her current position). In addition to a sense of engagement with the data, personally manipulating the data can stimulate insights, as another interview participant observed: "Sometimes when you're maneuvering around, you can come across some things where you're like, oh, it's not as bad as I anticipated. Or, oh, god, it's
worse than I thought it was. But you have to be able to move those things around and look at it individually like that" (High School Principal A). Ultimately, data-minded educators instinctively know that spreadsheets provide a value that PDF files do not. "Every day you get this stack of reports. It has some of the scores and some scores it doesn't have. It's all PDFs and it's just a full school stack. Every day. You just can't ... I guess if I were to sit up here all night and take all of that and plug it into a spreadsheet so I could use it" (High School Principal B).

Participants also expressed concerns about the extent to which principals had spreadsheet skills or had the time to learn or make use of those skills. The retired Assistant Superintendent worked with her district and another (district-level) technology product that she believed offered the advantages of data manipulation without the need for Excel skills.

I spent years trying to teach principals and data managers how to use pivot tables, how to take a simple Excel spreadsheet and pull the data in any format that they wanted. I just, I would say that less than a tenth of the people that I ever trained in using pivot tables ever went back and used it. That was where I was coming from, knowing how I needed to find a tool that they could have the data, trust the data, and be able to use it without having to learn the back end of it. (Assistant Superintendent for Instructional Technology)

This Elementary Assistant Principal, in a district which does not use SchoolNet, expresses concern about accessing data in a usable way.

In my mind, in a beautiful world, as soon as the data come in it's able to get into Excel or a file as soon as possible and it needs to get to somebody that knows what they need to do with it. [Central office data support staff] say that we just don't have
the manpower to quickly make that happen. Principals, or assistant principals, aren't trained really, at this point, to convert or change the data, if we give them that, to convert it to a teacher-friendly, digestible format. (Elementary Assistant Principal whose district does not use SchoolNet)

The capacity to manipulate the data triggers a connection to the numbers in a way that elicits insights and allows for meaningful conversation about action points. An elementary principal describes how he would use spreadsheets—manipulating the data as part of the conversation—with his staff to encourage staff analysis.

At that point, we get it in a PDF. I'm going to put it in Excel and take it to my 3rd grade team. I'll ask them questions to get them where I need them to be. 'What do you notice about this?' 'Oh, we did well, we did 60%.' Ok, let's look a little deeper. .... Because as much as we'll make a PowerPoint and show the results, they've got to be able to talk about it. I want them to be able to see this in Excel and just say ... what happens if this achievement gap were half of what it is? That number is going to go up tremendously. (Elementary Principal B)

Principal as data analyst. What is a data analyst? The Data Resource Guide defines this role as part of its description of a data team.

The Data Analyst presents an overview of findings from a review of current data and initiates discussion of the status and effectiveness of currently implemented practices and strategies. This person has access to the necessary data and performs a cursory analysis of data to present to identify the problem identified during the needs analysis that will inform and guide the team’s discussion. The person serving in this role should be comfortable with mining data live during the meeting and capable of
creating custom reports and graphs as the team digs deeper into the data. *(Data Resource Guide, p. 26)*

Data experts not based at a school have a perspective about principals in the role of data analyst based on the experiences they have had in supporting those principals. The research specialist was the most blunt.

[Principals'] background in data is non-existent. ...

They have no real appreciation for standardized assessment, or a background in data. Yet, now all of a sudden they're being barraged with different metrics. They don't have the capacity to even understand what it is that they are looking at, in a lot of cases. ....

The dashboards by themselves, the information by itself, are really not enough. They need more interpretive assistance. *(Research Specialist, referring to his district's principals)*

In one participant's district, the school-based support staff fill the role of data analyst. "I will provide reports to the principals. I don't think there are many administrators in our district that use Schoolnet. They usually depend on their curriculum people to get the data from Schoolnet and provide them with the information" *(Curriculum Specialist)*. These participants reinforce the value principals provide even if those principals do rely on data analysis by other staff members. For example, one of the support staff noted: "It takes a person to be able to take some of this information and be able to analyze it. Even though I might send out a description of what I'm sending, they need to know what they're looking at" *(Director of Testing and Student Information)*. Participants also address how the reality of the principal's day impacts time and mental energy to be devoted to analysis.
I've been in administration as an assistant principal. You have parents walk in angry over this and that. You have kids—especially our population—we have some very high-needs kids with mental-type issues, who have breakdowns, just a lot of high needs. When you're dealing with that, in and out of the office all day, working with social services and working with outside contracted therapists, to meet the needs of the whole child. To expect principals to dig that deep... I mean, yes, they need to be in the data and they need to know. But it would be very challenging for them to do all that and try to run the school. *(Curriculum Specialist)*

Finally, findings from principals themselves add to the understanding of their data access. "But as an administrator, I am comfortable enough, on a Saturday night, to pull up Schoolnet and go in and see what's going on and look at some reports to create my own reports" *(Middle School Principal)*. Next, a high school principal's walk-through routines illustrate the instinct for analysis data-minded administrators share. This principal showed me a clipboard of his school's class walk-through schedule. Across the top are the five administrators, including three assistant principals, one academic coach, and the principal. Down the left are dates listed in two week intervals, and filled in the cells are the hallways. The administrators rotate their assigned hallways. The form for recording the data was created by the school after they were dissatisfied with the form provided by the district. They have printed it on NCR paper so the observer can leave a copy with the teacher. The principal and his team meet regularly to discuss this data.

This principal also discussed the limitations of administrator roles on campus. As a participant noted above, specific training is difficult to obtain; data-based decision making is
an on-the-job type of learning. Assistant principals should be groomed as data analysts rather than constrained to operational logistics.

As far as administration goes, the trend in most places is that your principal is the arbiter of all the curricular and instructional stuff. Your AP [Assistant Principal] is in charge of the buses and the bad boys and the bells and stuff like that. Which to some extent your principal needs to be the instructional leader of the school. I completely agree with that. The problem is that your APs are your pool for your next principals. If you never give them access to that, then when they become principals ... If they're not intuitively into using data, then they are going to become principals who are still about bells, buses, and bad boys. But they're going to be overseeing instruction and they're not going to have the tools to know how to. (Elementary Principal B)

**Dispositions.** Themes related to "attitude or mood, or [a] tendency to act or think in a certain way" (http://www.merriam-webster.com), classified here as disposition, far outweighed either knowledge or skills. Although analytics is not a common term in education, educators do discuss and exhibit analytical thinking. They are also problem solvers, seeing internal improvement potential in the external demands they face. Educators recognized by NC DPI or their peers as data proponents are detail-oriented and organized, curious, motivated, and persistent. Several participants spoke in detail about an instinctive desire to automate their school processes. Responses about trusting data, situational awareness, and understanding the whole child also illustrate key characteristics of principals who will be successful users of data technology. The findings related to these themes are presented in this section.
Analytical thinkers. Educators who approach their school's data critically are seeking a more authentic understanding of student performance. Here an elementary administrator discusses mClass (reading assessment) results and subsequent interventions:

G to I. That's only two levels, but people were feeling good. Oh, they grew two levels. But then when you look at it, technically they should be growing four levels a year. And this is a child that has had, apparently, double dose all year long. That child should be making six levels of growth. (Elementary Assistant Principal)

A high school principal introduces his explanation of attendance problems masked by an overall satisfactory statistic: "Because you can look at our numbers and say that [our school's] attendance rate was 96%, and that sounds good, but when you really break it down, it's not" (High School Principal A). Looking at the data, ready for insights, is also a sign of an analytical approach. "I keep a lookout for any patterns that emerge" (High School Principal B). The technology vendor, a former principal, has analytical goals in mind. "You can build so much data to look at. But ... What are you trying to get at? What am I trying to tease out of there?" (Technology Vendor)

Problem-solvers. North Carolina's Data Resource Guide lists desirable qualities for data team members, and includes "Effective Problem Solvers ... Creative / Innovative Thinkers" (p. 27). The association of this quality with strong data use is borne out in these results. For example, one participant explained, "It's just my personality. I try to problem solve. .... The three of us that were in that position ended up creating this Excel document that evolved over three years" (Elementary Assistant Principal). Formerly, this assistant principal was an AYP (Adequate Yearly Progress, a function of the No Child Left Behind Act) Specialist for an elementary school in a different district. She created a dashboard of her
own in Excel that she called a Data Tracker, because there had been no effective way for the Professional Learning Communities she facilitated to monitor and evaluate student progress and the interventions teachers implemented. "People are wanting this information [student results]. Lots of times, the literacy coaches or the math coach, they would have to turn that information in to the literacy director or district office. Teachers were having to ... people were having to constantly email or turn in. This eliminated all that" (*Elementary Assistant Principal*).

A principal who intuits problems in the school needs a way to tackle those problems, as explained by this participant: "I think I see the need, just by being ... by dealing with the staff and students, and looking at things. Then I go to the data to have it help tell me where I need to focus" (*High School Principal A*). Further, effective principals know they must take action, and they know they need the appropriate tools. "You can't wait for it [a specific directive for improvement] to be just given to you. You have to go out and seek what it is that you want to accomplish. As an administrator, what goals do you want to change? Then, seek out what tools you need" (*Elementary Principal B*).

Finally, effective principals make internal improvements when tasked with external demands (Knapp & Feldman, 2012). One North Carolina district fully supports Home Base products, and intends to require use of certain other tools such as Edclick, software for managing discipline referrals. Thus, one principal in this district will leverage the new tool by improving the school discipline process via implementation of Positive Behavioral Intervention and Supports (PBIS). PBIS replaces a reactive behavior management system with a proactive one defined by explicit expectations, standardized protocol, and the use of evidenced-based research to improve school climate. "I know that our district will be fully
using Edclick, which is something that we can access through Home Base. I know that we'll be using that to help with monitoring of discipline. But also, because of that, we are also looking into having a PBIS team” *(Middle School Principal)*.

*Detail-oriented and organized.* Effective problem solvers and data users focus on details. The discipline approach undertaken as a result of efforts to improve school climate at a high school illustrate the attention to detail required for substantive improvements, as noted by this principal:

Then major, which is office-managed. Now, teacher-managed, which is minor, can become major if it's repeated over and over. Then we have a step process. Basically, it starts out with a student conference and warning that's documented. That's where it starts out. Well, that's probably not where it starts but that's where it gets documented first. I'm sure they do other stuff before then. The idea is ... the first step is give the student a chance to fix it. Make sure your expectations are clear; that they understand what they're supposed to do and why. *(High School Principal B)*

The Data Tracker designed in Excel discussed earlier contained high level data sorted by teacher, and extensive detail for each student. The former AYP specialist described this tool:

We were really big into re-testing. I taught them [teachers] how to go in and insert a comment. They would change the color to red. Retest meant red. My fourth grade group did that a lot; 3rd, 4th, 5th, more so than my K2. I could go in here and look and see ... That was a thing, too, because sometimes teachers would say, like ... Yeah, it looks ... We're in the process of retesting, and we believe in that, but they also thought it was important to note that it took some time. It took some time. Ok, retest
means red. So I could go in and see that this was a 3, but it was red. Or that's a 100 but it's red. I would hover over and it would give me the first score. *(Elementary Assistant Principal)*

What do effective principals need for data-based decision making? Principals who themselves are known as strong data users identify organizational skills as follows:

I've had assistant principals that I know want to go on and be principals, but they can't organize things to be able to ... In other words, they would get the spreadsheet and they would have a hard time manipulating it. You don't have to be a numbers person to know what you're looking for. I think, #1, a principal has to be organized to be able to use the data. *(High School Principal A)*

The following principal's efforts to organize the school schedule to simultaneously accommodate PLC meetings, online testing in the computer lab, and effective use of Teacher Assistants (TAs) illustrates an intense attention to detail.

We're going to create a master schedule on the board just like you do in high school. I think we’re the only elementary school to have one of these boards, but that's fine. That's the only way I know how to make a schedule. We are going to tie our specials so that once a month or so we can do an assembly, or a town hall meeting, and stack it on top of the specials so that each month the teachers get an hour and a half of PLC specific planning where they'll meet with the RITs [Reading Improvement Teams] teachers or the math intervention specialists, depends on where our weaknesses are. Go through and kind of mine through the data, find out ... *(Elementary Principal B)*

*Curious, persistent, motivated.* Desirable qualities in data team members include being "inquisitive" *(Data Resource Guide, p. 27).* The Phase 1 dashboard users emphasized
the questions their clients are or should be asking of the data; trying to understand why.
Similarly, strong data users in education are curious. "Each time I get data, I'm thinking, what have I not looked at? How deep do I need to go this time to give me a little more information than I had last time? (Curriculum Specialist)

Not only are effective data users curious, they are persistent about finding solutions, as pointed out by this participant: "Every time, just looking and saying, what am I missing?" (Curriculum Specialist) They are not satisfied with the status quo. The elementary principal described above is determined to accomplish the school goals of efficient testing online and data discussions in PLCs. "Getting that access—we don't have one-to-one, so we have to use the resources we have well. The best tool we have for that is scheduling" (Elementary Principal B). This aspect of a school administrator's disposition naturally surfaces in other ways. Here a high school principal explains his actions, demonstrating persistence:

One year, I actually ... we had ... our numbers [student enrollment] were so high that I took the cap off. I did it on purpose. I probably shouldn't have done this, but I took the cap off, instead of capping the class at 32, and let everybody go in there who needed to, because I needed another teacher, another English teacher. I took pictures, every day, the first 3 days of school, of kids sitting on the floor. We had some lawn chairs we brought in. Finally the director of secondary came out and he said, "You're crowded." I said, "I was telling you that before school started." (High School Principal A)

The Elementary Principal who organized the school's schedule for multiple purposes wasted no time taking action. He moved from a high school assistant principal position and had been
at the elementary level for three weeks at the time of the interview. The exchange below points out his immediate determination.

Interview Question: Was it [the white board used for creating the schedule] here before?

Participant Response: Oh, no, I bought it two weeks ago. *(Elementary Principal B)*

This same principal further illustrates the drive of a strong data user:

I've done elementary for three weeks. In that past three weeks ... We never did mClass or Read3D [at the high school]. We never did Moby Max or any of those things. I couldn't talk to you as educated as somebody who's been an elementary principal for 5-6 years. But I can at least tell you now that if a kid's at a letter J in second grade, they're behind. Finding that ... There has to be a sense of ... You want to find out information on your own. *(Elementary Principal B)*

Data users who are intensely curious about student performance are motivated. Another elementary administrator spoke of the drive to engage with student assessment results: "We would literally ... as soon as the scores came in ... She'd read it and I'd type it in. We'd quickly come up with it. We weren't waiting like two months later for the state to tell us, or ... the spreadsheet would be built and as soon as she'd get the data, we'd enter it in" *(Elementary Assistant Principal)*.

When principals are motivated they capitalize on data tools offered to them. District planners must task themselves with linking the motivations of principals with the technology being made available. One successful district technology leader offers advice to people like himself when reaching out to school principals: "You have to develop a motivation. They have to want it. In order to do that, I think you have to show the value" *(Research Specialist)*.
The school-based interview participants in this study were purposefully identified; they were known to be strong data users. Themes of timidity when faced with "numbers" did not frequently surface. Other interview participants in Phase 2 (the Research Specialist, for example) commented however on the fear of data among educators in general and the limits of statistical understanding. This Research Specialist described a teacher in his district who considered the 50th percentile as failing. The importance of data-related knowledge and skills is discussed elsewhere; however, it is important to note that according to these principal participants' descriptions of their own backgrounds, they were not math or statistical experts. They were strong data users, nonetheless, and motivated to make good use of data for decision making, as expressed by this principal:

Interview Question: What do you say to people who say, oh, I can't, I really don't have a math brain, data's not my thing?

Participant Response: If your goal as an administrator is to improve educational performance, you've got to learn it. (Elementary Principal B)

Desire to automate. The Elementary Assistant Principal who had created a Data Tracker in a former position did so because she grew weary of data collected on paper in various formats. Several principals spoke of using Google Docs to automate various school-wide tasks. "I took the discipline referral that was in place. I hate paper" (High School Principal B). "I've already introduced a lot of Google Doc stuff. I've thrown a lot of technology on them [the school staff]" (Elementary Principal B). Using data well correlates with a desire for efficiency.

(Mis)trust of data. This characteristic was described in both positive and negative terms. These interview participants were known users of new technology, and proponents of
data use in general. They did not express a fear of engaging with data themselves, but did occasionally describe other educators as being afraid of data; for example: "First obstacle would be overcoming the associated fear of the data itself" (Research Specialist).

Earlier, a theme from Phase 1 had emerged which referenced depersonalizing accountability with the adoption of shared organizational goals. Those industry leaders understood the potential fear of data or lack of trust in its use. In education, the fear of data due to stringent consequences for poor performance is often palpable, as noted by this participant: "We have this general fear of the data, as a meaningful piece of information, without making it a summative judgment about somebody's ability" (Research Specialist).

A few discussions centered on participants’ skepticism of district- or state-provided data. In several cases, this skepticism prompted an increased personal motivation for participants to engage with the data personally. "Once an administrator can learn do some of this reporting ... once they can learn about some of the reporting, then they won't be so quick just to take that benchmark data that say, the district runs for you, and take that as the gospel." (Technology Vendor) A principal's comments echoed this motivation: "As soon as testing is over—and unfortunately we use testing as that one-shot deal, statewide—I enjoy getting in there and really doing my own analysis. Then when I get the results back, comparing what I did to what they [the state] did" (Elementary Principal A).

Trusting the data also relies on engaging with the assessments behind the numbers. An effective Professional Learning Community (PLC) creates common assessments for reliable data about student performance. This participant explains how PLC work builds trust.
[Teachers in the PLC] were honing in on what that quality common assessment was going to look like. It was very rigorous, but also provided them with the data that they felt like, when they were putting those scores into Power School, that they trusted that data. It was good, solid data across the grade level. *(Elementary Assistant Principal)*

*Situational awareness.* One of the 21 principal responsibilities key to principal leadership, identified in a meta-analysis research study by Marzano, Waters, and McNulty (2005), is situational awareness. A dashboard is also described as designed for situational awareness by dashboard experts (Few, 2013, p. 31). In the interview participants' responses, this responsibility surfaced as "living in the data" or in examples of data collected in less technology-dependent ways by a principal deeply immersed in school-wide operations, and by principals who were an integral part of the community fabric.

During the SchoolNet trainings, the researcher observed presenters leading the audience in discussions of engaging with data. The need to "live in" the data was a phrase repeated several times during the day of training. In one of the administrator sessions, the presenter, another technology vendor staff member, advised principal attendees to spend time with School & District Data so that it becomes "where you live".

Interview participants also spoke of engaging with the data in terms of "living in" the data, "having your hands in" the data, "owning" the data, or working with "live" data. This sense of ownership of the data and a motivating sense of the data's importance is expressed by the elementary assistant principal, who compares her Data Tracker experience in a former district with her current situation:
So, just to try to remove some of those barriers, so it's not just me as a teacher feeling attacked by administrators, but knowing, all year long, where my students are. And me being able to share that data with them instead of them providing it to me. ...

I also realize that the further removed someone is from sort of, touching that data, then it just becomes like ... ok, for example, when I was in the position in [another North Carolina city], I lived and breathed the Data Tracker (that's what we called it). I was in it all the time, checking to see how someone did on their math topic test. Or checking on how many high frequency words they know. It was crazy. ....

But I know that when the three schools that we had up and running, doing this [using the Data Tracker], the assistant principals and the principals, and the AYP specialists, the three of us lived in this file, looking at it, having incredible conversations, asking questions. You know, what about ... this is happening, or it's not. There was immense value in us being in it. ....

Now someone is preparing that spreadsheet for me. Then I'll get it, and I'll look at it, but you're lost in the ... You don't own it. That lets me know how much that piece of owning that would then lend itself to ... the teachers. (Elementary Assistant Principal)

References to the size of school and number of staff were indicators of the extent to which principals need tools to manage data. One participant noted: "Fair and equitable are different. Until you come to that realization, or until an administrator comes to that realization, to figure out what's fair and equitable ... you can't do that in a school of 900 children without something that helps you and leads you there" (Technology Vendor).

Elementary Principal A works at a K-5 school of 120 students, and data for this school are less dependent on technology:
We're a small school. I pretty much know our kids individually. I know what they eat for breakfast! I know who their parents are. When something's not going well, usually we can pinpoint the kid. We use more of a personal touch than the computer-based stuff. ...

This particular teacher has done poorly over time with these particular skills. Those are things that right now I can see very clearly. I can see in my mind the cohort of the kids. (Elementary Principal A)

As a principal who was formerly at a large elementary school in an metropolitan area, she contrasted the data needs of the two contexts. "If I were a principal of a school that had 700 kids, I would really rely on others, probably, to sit down and say ... This particular teacher has done poorly over time with these particular skills." (Elementary Principal A).

Additionally, a sense of community was a strong theme for two high school participants. Both these principals were serving at a high school in the area where they had grown up. Both were deeply familiar with their school communities. As an example of a mindset of situational awareness, the researcher noted four video monitors of the school which were mounted directly above one principal's computer and main desk area. These were the type of video monitors which show multiple views of the school on each screen. In many high schools, these are monitored in the front office reception area or by security staff. This principal had them directly above his work computer. While he did not have a dashboard, this principal had nevertheless created a connection for himself to the real-time action of the school. His desire to live in the data—to maintain situational awareness—is exemplified by the positioning of these video monitors. This same principal emphasized the importance of a connection with the data:
You also have to think about what's populating the spreadsheet. I think sometimes they lose track of that. It's not the be-all end-all just because there's a number on that sheet of paper. That doesn't necessarily mean that it's very accurate. Data at my school ... I know a little more about what went into that data. ... I feel a little bit better about my data, that I control. But things that are out of my control I question a lot. (High School Principal B)

The two high school principals spoke about knowing their community, and the importance of talking to stakeholders. High School Principal B also warned, "I think that's another one of those things that you can fall into when you have too much tunnel vision when you're looking at data; you quit talking to people."

_Behind the numbers._ The final aspect of a principal's dispositions is the tendency to think in terms of the children or the school community which constitute the data. For example: "There's so many places you get the data from. It's not all about test scores. You're dealing with people" (High School Principal A). The other high school principal explained a series of events which affected his English II classes. His view of the data includes the narrative behind the numbers. "One of [the board members] is going to say, what did you do? Your English 2 scores fell 10%. I'm going to have to share that story" (High School Principal B). For school-based educators, data are complex and nuanced because the numbers represent people. Here a principal indicates his thought process:

I have a strong background in PBIS as well. So, just, the whole child, and what's going on. Reminding people that these are students, they're not just a number. Yes, our overall grade average is 86%, but we still have 20 students that didn't reach proficiency. Who are these 20 students? (Elementary Principal B)
School staff occasionally resent data they perceive as originating from sources unconnected to the reality of school life. Advice from a principal reveals this resentment:

Well, #1, Don't get tunnel vision on data. No matter how much pressure people try to put on you; how many numbers they throw at you ... That's what happens, you know? You come in with a plan, or you say something. People start throwing these numbers at you. They don't have a clue as to how those numbers were populated. All they have is a number. ...

But remember that you don't work with mathematically perfect objects. You work with humans. (High School Principal B)

Themes related to dispositions dominated the findings. Strong data users think in terms of analytics even though the term is not common in education. Additional characteristics of strong data users were presented next; they are problem solvers, as well as detail-oriented, curious, motivated, and persistent. Strong data users seek efficient operations and are receptive to web-based tools and technology which facilitates that efficiency. Further, these users respect the power of data but confidently question the numbers. They want to own their data, in the sense of a full personal command of what the data represent and how they are derived. Strong data users perceive data as information but not as a driver to be meekly heeded.

**Product.** The documents chosen for analysis, particularly North Carolina's Summary Information Technology Plan, articulate the public views of NC DPI, and therefore offer insights into the expectations of state planners for Home Base, in addition to interview participant data. Four themes emerged: the complexity of the whole product, which leads to the question of whether Home Base is an interface or a dashboard, and which also, among
other factors, impacts implementation across the state. Finally, partly as a result of priorities and partly as a result of implementation demands, there is a strong focus on assessment data to the exclusion of other school data. These findings are explicated in this section.

**Whole product complexity.** The Home Base Communications Guide addresses the question of the product name on its first page. The answer to the question depicted in Figure 18 below is that "Home Base is home to a suite of web-based technology tools. It houses several major components, including PowerSchool, Truenorthlogic, SchoolNet and OpenClass." Other Home Base users vary in their terminology even though these are users more familiar with Home Base products because their districts have signed on to use the optional tools.

*Figure 18. Illustration of brand confusion for North Carolina's Home Base. (screenshot from the Home Base Communications Guide)*

Those not familiar with Home Base might be excused for misunderstanding, as suggested by this non user: "We were able to use [another vendor's] tools to help us create some of those operations that are now are captured easily in Power School. Or Home Base, Home Base, sorry" ([Assistant Superintendent for Instructional Technology](https://example.com)). However, Home Base is not
familiar among users either. "Power School is the main thing, we call it" (Middle School Principal, in a district which has opted to purchase the additional products).

When I talk Home Base, that includes PowerSchool, PowerTeacher, SchoolNet, Open Class, the Educator Effectiveness (NCEES), the Parent and Student Portal ... that is all Home Base. If you're out in the schools and you say Home Base, they look at you like, "Hmmm". They just started the new system, the IM, where there's a single sign-on. Everybody's going through the NC EdCloud. In June, the director of technology sent out an email "You need to claim your account. These are the directions."

Because he said, "This is how you will get into Home Base." I honestly had some data managers who said, "I didn't think that was us!" (Director of Testing and Student Information)

The brand confusion may be unwittingly reinforced during the implementation process. The technology vendor staff points out:

It's a bit of a silo scenario at DPI. If you've ever had any interactions in a school setting, there's some silo-ing in that area as well. You work on SchoolNet, we work on PowerSchool. This is the EE [Educator Effectiveness] group. Even though they're all DPI, there's some silo-ing among them too. (Technology Vendor)

NC DPI acknowledges that stakeholders across the state are uncertain about the brand. The Communications Guide devotes the last seven of thirteen pages to recommendations for school systems; how to convey to the public the explanations outlined in the first six pages.

In sum, the scope of the technology is daunting, the implementation is unwieldy at best, and NC DPI recognizes the disruption.
The implementation of RttT technology initiatives is a colossal undertaking, involving hundreds of educational institutions, thousands of public school teachers and administers, and over two million students and parents. The introduction of such a potentially disruptive technology in such a short timeframe could create dissonance in the education system. *(Summary Information Technology Plan, p. 25)*

However, NC DPI distills its message to the following. "The overarching message that Home Base should convey is: Home Base is a technology suite of tools designed to elevate the craft of teaching by empowering teachers to learn, track, share and teach more effectively." *(Home Base Communications Guide, p. 8)*

**Interface or dashboard?** The brand confusion for North Carolina's Home Base is emblematic of a deeper question. Do North Carolina's principals have an interface which integrates access to multiple technology applications and resources, or do they have a dashboard? Given that educators are by and large unfamiliar with the term dashboard with its capacity for strategic planning as well as monitoring and evaluating the organization as a whole, the evidence for the answer to this question must be sifted carefully. NC DPI materials and staff depict Home Base as a coherent whole.

I definitely see [Home Base] as a system. It's a suite of tools to be used to support teaching and learning. One component of it is called the Instructional Improvement System, but to me, I see the whole thing as an instructional improvement system. .... Each of those pieces are truly important, and integral to the other components of it.

*(NC DPI Presenter)*

However, NC DPI Staff notes that dashboards are "an area we need to get to", adding that DPI has the "desire and the will" to get there. Some practitioners see Home Base as a
coherent whole and some do not. In addition, some educators are not only unfamiliar with the potential of a dashboard as depicted in corporate literature, they are also still reacting to the power of a single sign-on. An elementary principal observed, "I can go to one login to get to my NCEES [North Carolina Educator Effectiveness System], get to my Power School. This is the best I've seen it" (Elementary Principal B). Having spoken with users across North Carolina, the vendor notes:

The first thing that the teachers that worked with me would say was we always use lots of products. We had a gazillion passwords and logins. Nothing had the same naming convention. You know? This gives you one naming convention to get into everything. So you log in to Home Base, it gets you to your PowerSchool - your attendance and so forth. It gets you to your evaluation. It also gets you to your instructional materials and your assessment items. In theory, it's one stop.

(Technology Vendor)

In the course of the educator interviews, the researcher was often faced with describing a dashboard concept after having asked a question containing the term. Once he understood how a dashboard might function for him, High School Principal B quickly rattled off a list of indicators on a dashboard he would design. Emphasizing the fast-paced, unpredictable nature of a principal's day, he described how useful a "quick snapshot" of the school would be for making informed and quick decisions. Other participants reacted enthusiastically as well. "The dashboard model that you're describing, or Power School, or ... I would love it. I think that teachers would love it. Let me go to one place ... I would even go to three places if I had to! Let me go to one place where I could quickly, kind of, get something" (Elementary Assistant Principal).
While North Carolina's materials infrequently use the term dashboard, a 2011 SchoolNet promotional video of under three minutes refers to it three times as a dashboard, calling the principal view a "KPI dashboard" and noting the "dashboard tools". The speaker discusses the utility of SchoolNet for principals who need access to "high-level data for goal setting". While the speaker describes the assessment indicators for a full minute, he also briefly addresses "Student Enrollment and Attendance" as a KPI and gives an example of a school which "has set a goal of 10% of students involved in disciplinary events" and demonstrates how the indicators assist principals with tracking their own progress toward that goal. The presenter notes however, that "KPI categories for your site will vary."

**Implementation issues.** An implementation evaluation is not the focus of this study, nor is the focus an evaluation of the product itself. In this section, an overview of the product pros and cons is presented in recognition of the importance of the issues, and also as a way of illustrating the difficulty of conceptualizing the full potential of Home Base as a dashboard while technical issues persist.

Interview questions did not target a user's judgment of Home Base per se. In addition, selected participants were purposefully chosen, first as recognized Home Base users, and second as proponents of data use. These two populations do not necessarily represent North Carolina's principals, nor do their perceptions of Home Base constitute a survey of Home Base users. However, a sample of the views of Home Base users are laid out below, beginning with observations from the curriculum specialist and continuing with other users. A brief commentary follows.
Personally, I would like to see where the SchoolNet assessment piece and the Power School piece do talk more to each other. It's the same system - but it's still two different things you have to look at. ...

I'm not too sure that it's that user friendly. It takes a lot of time of just digging into it. It takes hours to sit there and figure out what all those reports are. How to get the report you actually need. In my head, I'll think, "this is what I want to see". It takes quite a while to get in there and figure out how I'm actually going to get that information. ...

It takes a lot of time to just dig around and all the different reports. There's a lot of data there. *(Curriculum Specialist)*

But seeing how this data is live ... you can go back to 1st grade, kindergarten. You can see this as it's coming along. That would be a tool I would love, if it was on a single sign-on. This is more live data. It takes, when you do the assessments, how many words can they read in a minute. Track that to see where kids are. *(Elementary Principal B, discussing mClass, a reading skills assessment tool not in the Home Base suite of products)*

Two years in, I do think that there's lots of usage in SchoolNet but I'm not sure that it's taken over from things you always used before. I do think that when people start to recognize the data flow of it, it can. ...

When I have 5 teachers come to me in one day "I can't get online!" "We can't do this!" I'm like, well don't do it then. Don't do it then! Stop whining and do what you do. Do your other things. You're losing ground. Step back and let it cool off. That's a lot of what has been going on in this state. ...
It occurs to me that there are a lot of principals who are going to say, yeah, we don't do that. Because (a) they've heard so much static and it's not worth it, or (b) they've had some bad experience with it anyway. But then those who have the teachers that have persevered, those that have really gone through; I think they are seeing a different story. I think that principal thought on this is influenced significantly by timing and implementation and technology in your district. Your opinion is so varied based on what you've dealt with. *(Technology Vendor)*

It's really funny to see [students in the hallway trying to get a signal for their devices], but that was one of the downsides to the tool. .... Or, when we had benchmarks throughout the district, when there were a lot of students accessing at the same time, it would knock students off, or they would have a hard time. Those would be the downsides, the concerns. ....

I know that PowerSchool went through, several times throughout this school year, where they had to do scheduled but also some unscheduled maintenance because it just wouldn't work. That frustrated some staff members, and it was tough to keep buy in even after initially getting the buy in and saying, hey it's a great tool, let's use it. ....

When you can't stay connected, it just frustrates you. ....

It's not principal-friendly. *(Middle School Principal)*

The state has made a lot of improvements to this. It's wonderful. You can go in here and at a glance see where your student is at. Are they on track? Are they missing something? Is there ... Do we not have them in the right courses? ....
Right now you have to export it. You have to know what test you're looking for, or it brings out everything. To me, I'm like, ok, well, bring out everything. I can filter what I need. *(Director of Testing and Student Information)*

Participant comment: There's a lot of scrolling for this.

Presenter: Yes, the pages are long. ....

Presenter: You can go with the defaults but it probably won't give you what you want, because life's not that easy. *(Observation commentary)*

These Home Base users (as well as DPI presenters and the technology vendor) are in agreement that there have been serious issues with connectivity and hardware, as well as the product and its implementation. For many educators across North Carolina, these issues likely overshadow any overarching dashboard potential from Home Base. For Home Base users, however, criticism is muted and tempered by hope in the product's possibilities. The middle school principal discussed the transition to technology in general among her staff. She had described the move to Google Docs for several organizational needs, her awareness of her staff's limitations, and how she as a leader could not expect too much too soon. She expressed the same patience and long-term perspective about Home Base:

*The support makes all the difference in the world. Even with the roll-out of SchoolNet and Power School and the changeover, allowing a degree of cushion as people make that transition is important.* *(Middle School Principal)*

She went on to articulate the value of SchoolNet, her expectations of the state, and issued a general call for patience even in the face of technical issues with the product or difficulties with the implementation, setting a positive tone overall:
I want our teachers to fully get some benefits from SchoolNet. I think the other side of that is a state responsibility to ensure that it's going to work, at least 90-95% of the time, because it's a powerful tool. When you ... when it's down, and you can't connect, and you have to send a third of the students out into the hallway, that takes away from it. You lose buy-in from your teachers. If we want to continue to move forward, we do what we can on that end, allow some room for grace, as I call it. I think the rollout will go well. (Middle School Principal)

**Product focus on assessment data.** In this section, a description of the inherent focus on assessment in SchoolNet, the Home Base product typically referred to by users when discussing data analysis, is presented. The presentation of findings related to data will continue in the next section with a focus on other themes related to assessment. First, the publicly expressed intent for SchoolNet:

SchoolNet will support the tracking of student activities and assessments directly linked to standards, benchmarks, and/or objectives. Assessments (student tests) or assignments may be linked to instruction and will feature either manual scoring or online delivery and automatic scoring. Based on student assessment results, teachers will be able to use the application to identify and assign instructional material to students that specifically addresses the weaknesses uncovered by the assessment.

*(Summary Information Technology Plan, p. 14)*

In the Home Base training (effectively SchoolNet training) the opening presenter asked, "How are Home Base and the instructional improvement cycle connected?" and answered his own question this way: "Home Base is a tool to facilitate the process." From the SchoolNet landing page, a central menu bar is depicted in Figure 19 below.
As shown in Figure 19, the current focus of data analysis is on assessment data in part because SchoolNet offers no other type of analysis. The technology vendor noted:

"Attendance and discipline are turned off, at this point, in production. Attendance and discipline data will be turned on because they are in the contractual agreement." She went on to explain some of the reasons the Home Base Implementation Team (which consists of NC DPI staff and vendor consultants) has delayed the inclusion of these types of data; reasons which are detailed in a later section.

Not surprisingly therefore, Home Base principals like the interview participant cited below see SchoolNet, and by extension, Home Base itself, as limited to data analysis of assessment data.

We've used [SchoolNet] to help identify strong areas and areas of weaknesses in our building. For example, when we looked at our data from our Explore assessments as well as from our end of year assessments with EOG and EOC tests we learned that our .... math in our building, we were suffering instructionally. Our students were not showing us what they needed to, with regards to proficiency and growth. We turned to that particular resource to help us with pre assessments and post assessments and then also to identify from the whole school level, what areas we were struggling in. We drilled it down to the actual classroom and then we drilled it even further to look at the students, different groups of students. From there, we have lead teachers ... everyone, they're not at the same point with the use of SchoolNet. We have our lead
teachers who then take that data and dig further into the lesson plans that are there, that are available, the units that are there, to help target those areas where students are still, after instruction the first time, not being successful. (*Middle School Principal*)

When asked by the researcher about "the problem Home Base was designed to solve," the technology vendor replied:

> As far as decision making, it would be my thought that we've got lots and lots of people in our state that have become very savvy with the assessment pieces of this. They're doing lots of benchmarking, lots of classroom assessments, lots of even school-made assessments that would be like for 3rd grade teachers to compare.

(*Technology Vendor*)

In brief, data analysis in SchoolNet is currently restricted to assessment data, despite its potential and NC DPI's own goals of data for school leadership. In the next section, additional data-related results are presented.

**Data.** This section completes the discussion of data. Documenting an exclusive focus on data for assessment purposes in education is not revelatory. NC DPI's 2013 Data Resource Guide described five types of data: demographic, program, perception, achievement / assessment, and behavioral, noting: "Of the five types of data, achievement/assessment data often receive the most attention in education and thus will be a primary focus within this Guide" (*Data Resource Guide, p. 3*). The curriculum specialist was the go-to data analyst in her elementary school. When asked what her administrators most wanted from the data, she replied, "Most of the time, the administrators, bottom line, they want to know about classroom proficiency" (*Curriculum Specialist*). Two additional themes central to data which emerged were the question of establishing rights and permissions to view data, and the
conundrum that no data can be analyzed until data are entered appropriately into the software.

**Rights and permissions.** Prior to Home Base, data access was in some ways simpler. A recurring reference in the Phase 2 findings was the obstacle created by privacy concerns, as described by this principal:

In NCWise, you could click on the kid and look at their transcript and look at all of their data. With PowerSchool you can, if you contact your data manager to get all that information. It's not that it's not doable, but you don't want to give all your teachers counselor rights. That's how it's done in the PowerSchool system. (*Elementary Principal B*)

The technology vendor explained at length one obstacle to including attendance data in SchoolNet (the data analysis tool of Home Base). She described the possible variance between what a parent sees on the Parent Portal (data from PowerSchool) and what an administrator sees on SchoolNet (which has a one day delay, and additionally may not reflect well a partial day's attendance). Another obstacle is the more traditional concern of student privacy. Comments by the technology vendor about privacy and permissions appear below.

You certainly have the ability from PowerSchool to figure out what roles and permissions you want people to have. Not only in PowerSchool, but in SchoolNet. That was never really the case before. Before, when we were, when we did Wise [NC Wise] and then whatever else, it was just a scenario where all administrators looked the same, all teachers looked the same. Now there's lots of variance as to what you can give somebody that is all of a sudden theirs to see and do. .... Discipline data ... some things are just not ... you don't get to know everything, ....
SchoolNet will allow teachers who teach those children to see what comes across for those on their roster, kids they teach. Think about the roles and permissions. If you were someone in my school who was an instructional coach... I've given you much more latitude to see historical data on children as far as attendance, benchmarks, EOCs, EOGs, just ... historical testing data even. What if your roles were such that you could get in and see all the disciplinary data flow across there. Some of that just doesn't feel right to me. (Technology Vendor)

This perspective was echoed at the SchoolNet training. "Attendance is coming soon to SchoolNet. Discipline may or may not come; privacy / rights issues" (SchoolNet presenter).

One of the non Home Base users had described a previous system's data analysis efforts, and her frustration with this same obstacle. "Even as a PLC we should be able to [access each other's data together]. Then you start getting into all these administrative rights, what happens, and who needs to have access to what" (Elementary Assistant Principal).

**Data in before data analysis.** Another obstacle to data analysis relates to the upfront work of ensuring that student data exists in SchoolNet. A presenter at the training discussed the grading cycle; she described the tendency of teachers to get caught up in grading assessments without subsequent data analysis. Related to this issue is the problem of creating assessments without linking questions to curriculum standards to facilitate that data analysis.

The frustration of the technology vendor about the use of her product was that some schools which have committed to SchoolNet use its resources for building assessments but then print the assessment and make copies on paper for students. Unless schools then manually enter the student scores back into the software, no data ultimately exist for analysis by SchoolNet. She describes this frustration, saying:
We have usage data that shows they've done three benchmarks this year on every kid third through tenth grade, consistently. Think of that number—big—then they've done some formative assessments on Social Studies which is not tested, it's not an EOC/EOG for them. They've done it consistently, on the computer, so the data flows through. But then we can also see where the teachers have made thousands of tests that were never taken online. They probably PDF'd them. What teacher ever made a test they didn't intend to give? They ran a copy and gave it pencil-and-paper. It never went in to the system, so there's no data there to review. You can't use it in that sense, to make good decisions. (Technology Vendor)

The director of testing and student information described in detail the process of converting her district's benchmark testing to online. For a certain period she provided answer sheets to teachers several times a year which she scanned, feeding results into SchoolNet. She explained:

We knew how to set up the assessment, because we didn't have to actually have the assessment in, we just had to get answers. I just want the answers, and the objectives that it goes to so we can scan and get some results. (Director of Testing and Student Information)

This year her district has managed to arrange for truly online testing, which will greatly facilitate the data being entered in and thus making analysis possible.

A big focus that we've got this year, is that all middle and high school local assessments will be online. Even starting in August, with our baselines. And that's huge, because the big thing with us was, can technology get the computers back out to the students by August 24. (Director of Testing and Student Information)
The elementary principal was immersed in scheduling challenges at the time of the research interview. He intended to accomplish two main goals: free up groups of teachers for PLC time and simultaneously create regular space in the computer lab for online testing. "I've actually created the schedule in a way such that ... We're not one-to-one." Being one-to-one, assuming connectivity, greatly facilitates online testing and thus data analysis via SchoolNet. He relates the planning process to accomplish the two goals:

We have a laptop cart that we can check out. Based on our specials schedule ... We have one [special] for the computer lab. Look at the blue tabs. The blue is for computer lab. I've tried to set it so that for two days ... it does two things. One, my computer lab person is a TA. That can give me a TA that I can float into the upper grades for two days, because they don't get anybody. I can float her for two days. It also opens the lab so that teachers can take their kids in there to do their SchoolNet assessments without disrupting the regular flow of instruction. (Elementary Principal B)

The school-based SchoolNet users are creatively tapping resources to facilitate data analysis. Surmounting the hardware access and connectivity issue is one of the challenges, and sometimes leaders find their students in the hallway looking for a signal. Ruefully discussing connectivity issues this principal noted: "We're in the middle of small town America, is what I like to say. We have a hard time" (Middle School Principal).

**Organization.** Instructional data as opposed to school-wide data are overwhelmingly the focus of Home Base products, training, and official documentation. Three additional but related school-wide themes are addressed in this section, however. Principals may not always be the best data analyst for their school, therefore other staff can reasonably provide data
management skills or interpretive assistance. Nonetheless, the principal is charged with establishing a data culture in the school as a whole and ensuring effectively functioning data teams (also known as Professional Learning Communities, or PLCs). Findings related to these themes are presented in this section.

**Additional staff roles.** Leaning on support staff to assist with data use is not limited to SchoolNet users. One participant from a school system outside of North Carolina said, "We mine public data sources in order to do comparisons of data across districts and across schools" (*Research Specialist*). Then speaking of interpretive assistance he offered to principals in his system, "[We do] that kind of processing information for them." Another participant, also unconnected to Home Base, discussed her district's data use:

> I would meet with the elementary, middle, and high school principals at different times. We literally would take their requests. If, let's say that math was an issue. If they saw that that the math scores were not as high as they needed to be on the most recent test, what we would do is we created reports that would give them information on student scores in that particular area. (*Assistant Superintendent for Instructional Technology*)

Although the data collected for this portion of the study are too limited to reach conclusions on this question, it is reasonable to wonder if the complexity of Home Base, and the newness of several software products (Power School and SchoolNet, for example) lead principals, even technology savvy proponents of data, to lean on other staff. For example, when the researcher asked for an expert user principal recommendation from the technology vendor, her first thought was not of a principal, but of a district staff person, who clearly was a key resource for her district's principals.
This district staff person spoke enthusiastically of helping her campus colleagues, saying, "If you're on the train, if you've got one foot on that train, then we can take you" (Director of Testing and Student Information). Although she described staff who were "high flyers" she also sends principals an Excel spreadsheet with all of their students' data three times a year so that "they don't have to go in here [SchoolNet]". The Curriculum Specialist in an elementary school in another part of North Carolina noted: "In this system I think the bulk of the data resides in the curriculum position." One of the principal users of SchoolNet said that she was comfortable enough with SchoolNet to go in on a Saturday and review data. However, she tries to "stay in her lane" and works with an instructional technology facilitator, a "veteran teacher, very strong, very smart, who is our PLC director, if you will" (Middle School Principal). The technology vendor, a former principal, discussed principal knowledge as knowing what to do with information. Here she describes a knowledgeable principal who needs assistance to extract actionable data.

Have your person who is the instructional coach pull out the reading information, pull out the math information. Have the grade level chairs present out that information. Have them talk to you about why it is happening. Pull out your EC [Exceptional Children] person and have them talk with the group about who from that data is getting what, what kinds of interventions you're doing. Then go forward and decide what you're going to do next. It's your game to run, but you're going to want to have all the pieces in your hand. (Technology Vendor)

**Data culture.** An articulate definition of data culture came from a non SchoolNet user. "The idea is that we are trying to create a culture, first of all that data is information that is neither good nor bad. It's just information. Then we're trying to get to a place where that
information has meaning. Then we can hope for informed decisions resulting from it”
(Research Specialist).

One principal, a SchoolNet user, had just moved into his role at an elementary school at the time of the research interview. After years of teaching and serving as an assistant principal at a high school, he immersed himself in the elementary context—attending a PBIS (Positive Behavior Intervention and Support) workshop, learning about mClass data—and when he spoke of dilemmas in his career, he referenced surveying students or staff for insights or researching a question, such as the use of ACT results for students attending community colleges. These examples of reactions to professional challenges correlate to a principal who will establish a data culture in the school. Articulating this theme most overtly, another principal, also a Schoolnet user, said:

It's been a lot of work on culture. As much as the data is important, and the instruction is important, being a part of a team has made a huge difference. We actually say, "This is the Wildcat Way." or "We do things the Wildcat Way". ... That's what we do, this is our way. If you're going to be a part of our team, this is how we are going to do it. ....

Our new staff members - we have to kind of help them come on board. That [academic growth] won't come through emotions. That's just going to come through, hey, this is what the data says. ....

This is [our school] and this is what we do. (Middle School Principal)

When asked about the limitations of principals and data analysis, when compared to the corporate environment, the technology vendor replied, "They are cross trained in a really
relevant way! And we're not" (Technology Vendor). She believes that teachers are key to principals moving along the data analysis continuum, noting:

I think the teachers need to tie it all together. Like we were talking about the assessment, the review of data, and then the instructional pieces. They need to tie it all together. Once that's the done, the principals need to see how they can pull that information and see those very things we're talking about. (Technology Vendor)

**Professional Learning Communities (PLCs).** PLCs, Data Teams, and School Improvement Teams are vehicles of data analysis and action planning. Integral therefore to successful principal use of data dashboards is the functionality of these teams; without them, data remains not actionable and school improvement out of reach. This section begins with NC DPI's expressed perspective of the principal role on the data team:

Principals monitor the work of the School Data Teams, conduct brief but regular meetings with the team, and offer resources, support, and assistance where needed. The principal’s presence and support is as important long-term as it is during the formation of the Data Team. The principal can support the work of Data Teams by providing the time, resources and the authority for the Data Teams to do their work. If the principal is a member of the Data Team, it will be easier for the principal to understand what is being asked of the Data Team, what kinds of analytic tasks are being conducted by the Data Team and what recommendations are being made to the teachers. *(Data Resource Guide, p. 25)*

Principals must provide "the time, resources and the authority" for Data Teams to exist.

Further, whether or not a principal is considered a data analyst, it is clearly advisable for the
principal to support the Data Team long-term and to grow in data analysis skills along with them.

Although discrete skills for effective data analysis can be identified and improved, much of the value occurs in the conversations educators have. Examining data together prompts an engagement with the instructional process. Copland, et al. (2009) call this a culture of inquiry. The two examples from interview participants which follow highlight the value of the conversations, but Copland, et al., note that a "central part of the culture of inquiry is that it characterizes the organization, not just a few key players" (2009, p. 159).

Those kinds of conversations don't typically happen. But because we can see each other's kids, because we share them ... Think about the value in that conversation. It almost becomes non-threatening. She's probably a poor student for you, that you're carrying. Everybody else is talking about what a powerhouse of a student she is.

You're shaking your head. All of a sudden, it's not just your problem. She's not a good reader. She becomes our student. (Technology Vendor)

Similarly, this principal highlighted collaborative work:

A lot of my passion for this comes from my strong belief in PLCs, and those collaborative discussions. For the first year, it was kind of like, uh, this is my data, not your data. But toward the end, we were able to have conversations. ....

Our team was ... it was because we're so tight—we know exactly where our kids are at any given moment. It's not like my homeroom or your homeroom. They were our kids. (Elementary Assistant Principal)
Next, the middle school principal describes a school where the leadership targets the academic tone in the building. As the principal, she recognizes that an effective school is more than the sum of individual classrooms, remarking:

One of the things that we are working on, looking at, is our strategic planning for the district and then narrowing it down to our individual school improvement plans. One of the things that [our superintendent] has specifically asked us to ensure we do is weave in Schoolnet because it does such a good job identifying large gap areas and smaller gaps in instruction. ...

When I first got there it was a very closed-door approach. Great teachers didn't want to share their ideas. This is what's going on in my room. These are my 60-80 students and I don't want to share out. We've created a very collaborative environment. Our school has shown growth because of that. We have a lot of work to do, but we've come a long way. (Middle School Principal)

Summary of Findings

This chapter presented the findings of the research seeking an understanding of the knowledge, skills, and dispositions necessary for K-12 principals to be successful with the use of data dashboards for school improvement. The research data consist first of industry expert interviews (Phase 1); the second and larger part of the research data consists of interviews with Home Base users and non users, observations of Home Base product training, and official Home Base documents (Phase 2).

The statewide implementation of North Carolina's Home Base provides a means for examination of dashboard technology in education. A review of models from Phase 1 and Phase 2 of this study, presented in the next chapter, will articulate how individual users best
make decisions based on data, and will also articulate lessons for educators based on the experience of other industries. Analysis of the data comprising Phase 2 of this study also serves as a reality check on the intended or ideal use of a data technology system such as Home Base in North Carolina.

The research question is addressed through improved understanding of how dashboards affect decision making. The themes presented in these findings suggest specific action for educators seeking improvement in the use of data technology, and also provide the impetus for policy and future research recommendations. The next chapter discusses these suggestions and recommendations.
DISCUSSION

This chapter discusses findings from the research examining principal knowledge, skills, and dispositions essential for effective dashboard use. A case study of the North Carolina Home Base technology implementation further presents a view of reality for the data-based decision making conversation in education. Implications for educators are discussed, and practical recommendations for principals and state leaders are offered. The chapter concludes with suggestions for future research. These findings and the subsequent recommendations are important to education planners in general and specifically for the professional development of principals in the face of dashboard technology implementations.

In North Carolina, education planners point to the perspective of "if we build it, they will come" as problematic (NC DPI Staff). Offering new data technology does not therefore lead seamlessly to improved decision making. Professional development, as well as structuring a professional experience for school leaders, are valued (NC DPI Staff); thus the findings of this research are relevant. For NC DPI and similar state leadership around the country, this study presents an explanation of how developing principal knowledge, skills, and dispositions will increase effective dashboard use and lead to systemic school improvement.

Summary

Dashboards are more common tools in other domains than in education. An examination of dashboard use elsewhere offers insights to educators; the examination of this other use comprises Phase 1 of this study. Phase 2 offers the education view of dashboards, as well as a perspective of the reality for intended dashboard use in North Carolina. Offering these insights in the form of a logic model accomplishes several purposes. First, data-based decision making is a common refrain in education (Marsh, Pane, & Hamilton, 2006); to the
point that practitioners can lose sight of practical and specific steps for schools to take. A
logic model forces a tangible and detailed view on a concept; this is particularly helpful in
the case of data-based decision making, which can tend to be vague or dissociated from real
meaning.

A logic model also offers a means to target recommendations for action. A theory of
change explains the program in a way which provides a framework to approach program
improvements (Weiss, 1995). This chapter discusses the findings related to how change
happens (explored via the industry expert interviews in Phase 1) and how change is expected
to happen (explored via the educator interviews, observations, and document analysis in
Phase 2). The logic model which articulates the theory of change offers state leaders a
practical way to tackle data-based decision making with dashboard technology.

The research question asks what knowledge, skills, and dispositions contribute to
effective principal use of data dashboards for school improvement. This question is
addressed through improved understanding of how dashboards affect decision making.
Insights from the research of this study include lessons for educators from other industries,
lessons from strong data users in education and lessons from a comparison of intended
program theory to practitioner reality. Following this section, this chapter continues with an
explanation of the limitations of the study. Next, a discussion of the findings presents the
lessons described above, and then more specific recommendations are presented, for
educators in general as well as specifically in states such as North Carolina which are coping
with a state-wide implementation of dashboard technology. The chapter concludes with
suggestions for future research.
Limitations of the Study

This study is limited simultaneously by the nature of exploratory research and by the narrow, in-depth character of a case study. A wide range of data were collected with results offering a description of data use reality in several domains. The focus of the research is to present an overall understanding of data-based decision making in the presence of a specific technology tool (a dashboard) not only ideally—in business and in education—but also specifically as planned in North Carolina. The goal therefore is "discovery rather than verification" (Ambert, Adler P.A., Adler, P., & Detzner, 1995). The focus on principals and the uncertainty of the product (is it a dashboard?) further constrain the results and are presented in their own sections below.

The concern arises with the question of whether or not results from a study undertaken on the cusp of a new technology adoption will be immediately beneficial to educators. However, tangible recommendations will be made which North Carolina, or any state facing a large scale implementation, could follow to improve its interim results. Long term considerations for education planners will also be outlined. Nonetheless, for the most benefit, future research will need to select the pressure points at which the most value can be expected and initiate a targeted study to develop tools (assessments, for example) designed to assist educators in upgrading their skills, or to assist technology vendors in improving their products.

In this study, an increased understanding of how data users can leverage dashboards for best practices with decision making offers an intermediate step between what is known in other domains about dashboards and how educators approach them. Further, the case study of North Carolina sheds light on the complexity of a large technology implementation, and
implementation itself will always be influential in the process of moving from simplistic data reporting to analytics.

In many respects, North Carolina dominates the discussion of this study. Will the study's results be helpful to other states? At this point, the limitation described above of a broad study designed for discovery evolves to a limitation due to a narrow study designed for depth. The case study's extensive description of a particular implementation narrowly focuses on North Carolina. Despite this limitation, the study nonetheless provides deep understanding (Merriam, 1988) of one state, offering other educators enough information to sift for applicability to their own situations.

**Principals Versus Teachers**

The focus of this study is the principal, while much research attention is directed to teachers and instructional data use. Further, the theme of recent SchoolNet professional development for educators is geared to the instructional improvement cycle. SchoolNet, as the key analysis product in Home Base, aligns assessments (data and analysis) with curricular resources with the goal of improving instructional effectiveness. It remains true however, that although the core work of a school is instruction, the principal plays a key role in organizing the environment of the school to facilitate or hinder classroom instruction (Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010). In their study of effective schools in Chicago, Bryk and his colleagues highlighted two areas of school improvement under the control of the principal: organizational management of the school, and planning and evaluation of school-wide programs.

In addition, during the collection of interview data, NC DPI Staff emphasized that Home Base is absolutely a principal tool, and that principals are key stakeholders. Thus, this
research focus on principals is valid. Even so, a concentration on the principal in the face of the more prevalent research interest in teachers and instruction, as well as the admitted focus of the technology products themselves on teaching and instruction complicates this research.

A True Dashboard?

In addition, this study highlights the value of a dashboard specifically rather than data technology in general. Whether or not North Carolina actually develops and supports a dashboard (as opposed to an integrated platform) will be discussed in this chapter. NC DPI Staff stated that "the dashboard is a vision"; seeming simultaneously to set the bar to the higher level of the dashboard and also admit that the current implementation has not reached the goal yet. Regardless, the existence of a dashboard being open to question also complicates this research. The potential of a dashboard in education, however, will be clearly established and a valuable outcome of the study. This potential is so great that the research presented in this study is worth the risk. The dashboard is a transformative tool specifically for the principal, who monitors the functioning of the school as a system, and is a leader with data use and school improvement.

Discussion of Findings

In this section, the findings are discussed in four parts, as outlined in Table 6 below. First, what insights can educators gain from the corporate view of dashboard use? From the research literature and from Phase 1 interview participants, a picture of successful dashboard use emerges which will be useful to educators. Second, people using data technology in education, whether the North Carolina Home Base product or another, offer perspectives to further refine the understanding of dashboard use for educators. The third section discusses the logic models presented in the previous chapter and compares the Phase 1 and Phase 2 models. The fourth and final section reviews data from those in North Carolina most closely
connected to the Home Base implementation, as well as from observations and document analysis. This discussion of the theory-practice gap discusses how Home Base is intended to improve decision making and includes lessons from program theory, describing the relationship of program theory to practitioner reality.

Table 6

Lessons for Educators

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Lessons from Dashboards in Industry

This section begins with a discussion of terminology issues and how lessons from a few key words can improve educators' experiences with data. Then, results from Phase 1 related to the most important factor impacting the answer to this study's research question, the people who are the users of the technology, will be discussed. Following that, brief discussions of the product, data, and organization which enter into the interaction will complete the presentation of how educators can leverage the corporate research base as well as practitioner expertise from other domains. First, though, it is important to speak the same language.
Analytics refers to the reasoning which occurs in the presence of data and is a common term in corporate parlance. Technology has the power to organize and manage data to trigger human interpretations and reactions which extract or build knowledge from information (Petrides & Nodine, 2003; Velcu-Laitinen & Yigitbasioglu, 2012); this is analytics. Using the term analytics comfortably in education circles would illustrate a path from data access to improved decision making; a path which for many educators is ill-defined. Educators demonstrate analytical thinking when they are not satisfied with simplistic numbers and delve deeper into school data, such as when High School Principal A recognized the attendance problems at the school despite an overall attendance rate of 96%. High School Principal B intuitively understands analytics when describing the need to look "for any patterns that emerge" in the school's data.

Reporting, in the corporate lexicon, refers to a static presentation of data. The Senior Account Executive sees his company's tools as a way to assist with making proactive decisions "instead of just reporting". However, the SchoolNet training refers frequently to reports as a means of pulling information together for analysis, in a quasi-static sense of the word. A SchoolNet dialogue box asks users whether they want to create a PDF file or export to Excel when they have chosen "to run a report". For educators then, the conflict is between a report as a PDF file or a report in Excel, and discussions of this choice are telling. For data-minded educators a PDF file is not for analysis; a PDF report "is dead" (Elementary Assistant Principal). High School Principal B gestured dismissively toward a stack of thick folders on his desk, wondering what he was expected to do with all that, saying he just waits until he "can get them in a spreadsheet". Spreadsheets then, particularly the reliance on Excel, are the
means for analysis. Spreadsheet skills and recommendations for educators are presented in later sections.

As educators such as the principals mentioned above are introduced to the technology tools which are meant to elicit improved decision making, they need to be introduced also to the terminology which can allow them to profit from corporate research and experience and thus take their analytical instincts to the next level. The practice of these principals, in light of what can be understood from corporate experience, focus attention on "standard ways of doing things in the school and [thus] how, if at all, these standard ways of doing things [might] change in response to data use initiatives" (Spillane, 2012, p. 117). The sections immediately following discuss Phase 1 findings related to people as well as the product, the data, and the organization in which the interaction among them occurs. These findings illustrate lessons for educators' practice.

**People.** Clearly the corporate world has a well-established precedent for additional data analysis roles; outsourcing the analytics needed by industry functions well. Four of the five industry experts who provided interview data in this research are employed by companies who specialize in providing data access as well as analytics to particular domains. In education, roles for data analysts on a school campus are evolving, and are discussed in a later section. One lesson from the corporate data environment may be to embrace a school version of outsourcing. Other lessons relate more specifically to the knowledge, skills, and dispositions of successful dashboard users.

**Knowledge and skills.** Agility with spreadsheets or other technical skills are typically assumed in the corporate data culture. When asked about the knowledge or skills needed for successful dashboard use, corporate expert responses center on analysis and business
processes to support action. Two points add meaning to this theme. The Phase 1 interview participants represent five unique dashboard use contexts. Their responses do not combine to create a coherent picture of one dashboard product in the way that Phase 2 interview participants discussed North Carolina's education technology. Second, as stated above, four of these five participants were marketing analytics; to a greater or lesser extent, they sell a technology product and human expertise for analysis. To be successful, their product must fit naturally in the environment to which they market it and be intuitively used by the clients. While training is discussed, the emphasis is on what their clients use the product for, not on training clients to use the product.

Effective product design and intuitive use are tacitly understood in the corporate dashboard culture. A common theme among these experts was helping the user figure out what information is needed; helping them ask questions of the data. The second part of that equation is to then figure out how to obtain the information. The first part—setting up the question—was addressed extensively by Phase 1 participants. The second part—how to access and extract the information to answer the question—was not. By contrast, educators find the second part of the equation difficult at this time. In the later discussion of findings from interview participants in education, there are possible explanations, and insights which may suggest where educators are on a dashboard adoption timeline.

One industry participant spoke of intuition in the sense of industry knowledge; describing the role of data to bolster and augment a knowledgeable client's expertise. Knowledge specific to the data tool in industry is not a factor; the tool is meant by design to be intuitive. Users are expected to expend mental energy on analytics and action steps rather than on accessing data.
**Dispositions.** Whether a function of the assigned role of a user or as a result of innate qualities, one characteristic with enormous impact on dashboard use is a user's ability and willingness to look at the big picture. A user focused closely on accomplishing specific tasks in a specific way is less open to new tools or insights from data. Recognizing the limitations of a task-oriented perspective can offer an understanding of obstacles in the way of improved decision making. Simply offering a new tool to a user with this perspective will lead to limited results. Another approach is to consider the role or style of the user; those seeking answers and an overview of "the data that drive the business" (*Chief Analytics Officer*) are likely to profit from a tool which facilitates insights from data, while managers who monitor operations could equally benefit. The question of leaders and managers could become a framework for the purposes of data tools; a way to articulate the use of the tool for either role or style.

A recurring theme among industry experts revolved around asking questions of the data, seeking to understand why. Analytics as an operational mindset is an interactive process in which users engage with their data. This process can be facilitated by a sophisticated and intuitive product; analytics as an approach is best captured by the interaction of the people, product, data, and organization described in this study. Educators, though they may not speak of _analytics_, exhibit analytical thinking in various ways, as discussed in earlier and later sections. The data-minded educators interviewed in this research also seek to understand why. Furthermore, educators often speak of the children represented by the numbers. To educators such as High School Principal B, who sought to avoid "tunnel vision on data", and Elementary Principal A, who emphasized that she works with humans, not objects, the
concept of seeking to understand the why behind the numbers resonates. Analytics, to educators, will provide an authentic and valid approach to data use.

**Product.** The contribution of the best dashboard tool is to facilitate the interaction of people with their data without requiring focus or extensive training on the use of the product itself. Research literature which addresses dashboard design cautions against extraneous color and design features which interfere with the basic function of the tool (Few, 2013): to allow access to data in ways which encourage insights. When users expend too much mental energy navigating the tool, they have less energy for analytics and action plans. Effective dashboards also use visualization in sophisticated ways to help users cope with a high volume of data.

Interview participants emphasized the need for drill-down capabilities in order to move from information to action. Insights from data at a school level, for example are not actionable in the way that specific details are. If High School Principal B had a dashboard, discipline referrals would be a key metric. School climate was important factor for him, and yet general understandings about how students and staff do or do not feel safe, or overall numbers of student discipline referrals, are not actionable. Drilling down to specific campus locations where problems occur, or seeing numbers by time of day offers this principal a way to take reasonable action.

An effective dashboard tool offers a means to facilitate not only individual analysis but also coherent teamwork. One industry technology designer viewed this as "giving visibility into the process" (Web Development Manager). The Professional Learning Communities (PLCs) in education are closely tied to data use; data tools available to educators hold great promise for enabling the instructional data-based decision making of
PLCs. Dashboards therefore function as a vehicle for users to collaborate and share understandings.

**Data.** A lesson for educators who expect to advance their data use via new technology is that data quality will drive the effectiveness of any tool. If the high school principal mentioned above seeks actionable data points in order to improve his school's climate, but discipline incidents are not recorded in such a way as to access information by location in the school, it will not matter that his dashboard tool has a drill-down capacity. Educators will need to learn the limitations of their data even as they explore the capacities of new tools.

The research literature strongly suggests the solutions data visualization can offer to users who are overwhelmed by information (Huang, Liu, & Chang, 2012; Johnson, Levine, Smith, & Stone, 2010; “National Visualization and Analytics Center, Marketing Brief”, 2009; Scholtz, Cook, Whiting, Lemon, & Greenblatt, 2009; Velcu-Laitinen & Yigitbasioglu, 2012). Educators risk becoming paralyzed in the face of streams of data and increasing expectations for effective data-based school improvement. To counter the paralyzing effects of information inundating educators, technology tools need to be evaluated for their ability to visualize data in ways that promote analysis and action. Corporate users discuss visualization and the insights it triggers in terms of their product—the dashboard—but educators have for the most part not yet experienced the benefits of a product which visualizes data in helpful ways. Educators already feel overwhelmed by data and may react to the implementation of a new data access tool with skepticism. In an instinctive effort to stem the flood of data educators may unwittingly reject the very tool which is designed to control that flood. It will
help for educators to understand power of data visualization; lessons which may be learned from corporate experience.

**Organization.** One of a dashboard's key benefits is to enable organizational strategy. The literature has shown that an organization which successfully aligns its goals and strategies with the data it collects—the metrics on the dashboard—will most effectively leverage the dashboard itself as a decision-making tool (Eckerson, 2005). The importance of an organization's shared understanding of the metrics was noted by one Phase 1 participant: "There has to be a common lexicon of definitions" (*Chief Analytics Officer*). Effective dashboard use must be based on this shared understanding.

Another interview participant pointed to a tangential benefit of a focus on standards (facilitated by the dashboard). Honest discussions of individual performance with employees are difficult in any domain. If a shared understanding is established, bolstered by a third perspective (the data), a conversation about performance can be depersonalized. According to the business advisor, given clearly defined standards and organizational metrics, "it's a different conversation". For educators, new technology tools have the potential therefore to constructively change the accountability conversation by using dashboards to communicate organizational performance in a less personally threatening way.

Dashboards can trigger an evaluation of roles and processes in an organization. In terms of roles, with the assignment of responsibilities should come the power to make changes. If a dashboard user is not empowered to make change, the dashboard's insights cannot translate to meaningful action. In terms of processes, action is the focal point of data-based decision making; the capacity to make decisions and enact change make data analysis become school improvement. Having begun in the manufacturing environment and now
known throughout business, Six Sigma is a means of process improvement, reducing error and introducing statistical modeling for the identification and analysis of action steps in a process ("What is Six Sigma?", n.d.). The Research Specialist mentioned the impact of his Six Sigma training from a former profession on his career in the K-12 world. The Chief Analytics Officer referenced Deming and his work for the establishment of a culture of continuous improvement (Gabor, 1992). As discussed in this study, the field of program evaluation also offers a framework for articulating processes, or taking a program idea and clarifying action steps. Educators need such a framework, whether it is provided by Six Sigma, Deming's principles, or program evaluation. Schools which seek to ensure establishment of quality processes—effective actions taken as a result of data analysis—are more likely to see school improvement result from dashboard use.

Lessons from Users of Data Technology in Education

In this section, findings related to the dispositions of successful data users are discussed, with a focus on data use as facilitated by dashboard technology. Key points emerging from findings related to knowledge and skills are expressed best as practical recommendations and will be presented in that section. This section begins with two strong themes related to effective dashboard use: situational awareness and analytics. Then, an understanding of individual-level characteristics less tangibly tied to dashboard use, as well as characteristics of the individual as related to the organization are presented. This section concludes with a discussion of the importance of a solid framework for the process of taking action.

Situational awareness. A common comparison made by data users in education is "live" data versus "dead" data. A PDF file for some equates to "dead" data; static and
complete; with "live" data available via spreadsheets. For others "live" data are current and up to date; or data that are actionable as opposed to broad or summative and therefore unhelpful. Many proponents of data-based decision making in education also talk in terms of "living in" the data. "Living in" the data occurs when the numbers must matter to users in a substantive way, and data access is not mediated by too many layers of other staff, particularly staff not directly connected to the school. Principals who "live in" the data (whether data collected personally or as facilitated by a technology tool) are also more likely to develop or possess situational awareness, a key principal leadership trait, as identified by Marzano, Waters, & McNulty, (2005).

A good dashboard is designed for situational awareness (Few, 2013) and offers an essential school-wide view which cannot be otherwise captured by educators facing intense daily responsibilities. Educational data use research literature repeatedly notes the obstacle of limited time (Boudett, City, & Murnane, 2005; Copland, Knapp, & Swinnerton, 2009; Corn, Byrom, Knestis, Matzen, & Thrift, 2012; Datnow & Park, 2009; Lasley, 2009; Wayman, Spikes, & Volonnino, 2013), and Bain (2007) describes the difficulty of school reform while educators are simply trying to survive each day. For educators to contemplate school improvement efforts, daily organizational management and the improvement efforts must be supported by effective data technology.

The best dashboards function not simply as a data access tool, but even more as a tool which visually presents information in ways which enable efficient human processing. The flood of data, understandably rejected by many educators, becomes information packaged for use so that the segue to analysis becomes smooth. Appropriate action (the decision making in data-based decision making) becomes the focus. In the complex interaction of access to data,
analytics, and action, no single step is simple. Taking action, as addressed briefly later in this section, merits its own attention. Dashboards can lessen the intense focus on data retrieval and shift users' mental energy to the steps of analytics and action.

For educators who are uncomfortable with data (perhaps because they associate it with accountability and consequences, perhaps because they believe themselves to be ill-equipped for dealing with "numbers"), dashboards offer a more comfortable connection to data. Instead of receiving data about specific elements of the school in a way that seems unconnected to their reality, these educators can interact with a more holistic view of the school community. Many educators instinctively gravitate toward a perspective of what the numbers represent; the children they know on their campuses which populate the spreadsheets of data. For some educators, it is an understandable reflexive action to point out to others that schools do not deal with "mathematically perfect objects" (High School Principal B). For others a rejection of "the computer-based stuff" in favor of a "personal touch" (Elementary Principal A) occurs because these principals feel that they know their students personally. Dashboards can offer a holistic view of a school, a perspective which will resonate strongly with many educators, and perhaps particularly those who may otherwise distance themselves from data.

**Analytical thinking.** Data use is a continuum, and naturally principals will fall on different points along that continuum. Recognition and development of the characteristics which demonstrate analytical thinking can help identify principals which, although they do not have dashboard skills, would be most adaptable to effective use of a dashboard. These characteristics include instinctively looking to the data for answers and not always being satisfied with what is first presented. For example, the elementary assistant principal
examined the reading level growth of students who had had a year's worth of supplemental reading instruction. Although the students were making growth in reading skills, their growth was not commensurate with the strength of the intervention. Other characteristics include looking for patterns in the data and formulating questions to ask of the data. Principals who exhibit these characteristics are active participants in the data analysis process; they possess an inquiry habit of mind (Earl & Katz, 2006). These principals would not expect data to prescribe action but instead would recognize "the inherent ambiguity" of the data (Copland, et al. 2009, p. 156).

**Individual attributes.** Several themes emerged which contribute to an understanding of data use as a whole. Strong data users are clearly more likely to be proficient dashboard users, and to appreciate the benefits dashboards offer; dispositional characteristics of these strong data users are presented here.

Elementary Principal B recommended that administrators "seek out" the tools needed to accomplish their goals. Principals who are problem-solvers not only welcome new data technology which is offered to them, but also, as in the case of the elementary assistant principal and her Data Tracker created in Excel, will initiate a way to solve a problem.

In the 2012 study by Knapp and Feldman, the principal was identified as the link between external and internal accountability; leveraging external demands for internal improvements. Examples of this type of principal leadership emerged in the interviews. Schools in the district of High School Principal A are required to do walk-throughs (short, frequent, less formal classroom observations). This principal and the administrative staff viewed this obligation as a data collection assignment. They organized a process for collecting, analyzing, and acting on the data. The middle school principal noted that she was
required to use a particular software for discipline data. "Because of that," she said, "we are looking into having a PBIS team." This principal recognized that complying with the external demand meant storing discipline data in Edclick. An internal improvement meant establishing a discipline philosophy and school-wide approach, supported by Edclick.

School improvement which is tangible and substantive requires detail-oriented leadership. When High School Principal B could describe the school's discipline process in detail, it became clear that the school is led by a principal closely connected to the action steps of school improvement. In addition, faced with scarce resources and increasing demands, effective principals are challenged to organize their schools for data analysis. Elementary Principal B, with only high school experience, began his elementary assignment by creating a school-wide schedule to provide multiple outcomes he was seeking, including PLC time for teachers.

Intertwined with the dispositional characteristics already discussed—an analytical approach, problem-solving—are the qualities of curiosity, persistence, and motivation. Principals who are effective users of data and the most likely to be receptive to data tools are determined to find answers. They approach data and dig, seeking more and more answers. These characteristics would logically be associated with strong principal leadership in general, and could be used both to identify future leaders and as part of a framework for the development of dashboard skills. Dashboard skills of course include the capacity for extracting data. The technology vendor, a former principal, describes this as principals who know how "to work a scenario that gets them information". However, more importantly in the long term, dashboard skills include the analysis and application of analysis for the ultimate goal of school improvement. To limit the development of principals to dashboard
use in the narrow sense of how the tool functions (where to click, what the naming conventions of reports are) would severely limit the impact of dashboards on substantive school improvement.

Principals who exhibit a desire for efficiency in school operations will instinctively see a dashboard tool as a means to productivity. More specifically, a desire to automate routine processing, a natural tendency to look for web-based tools (such as Google Docs) to facilitate school operations lends itself logically to using a data technology tool effectively. This desire to automate springs from an instinctive understanding of the "psychological processing" described by Cousins and Leithwood (1993, p. 309). These principals are preparing information for themselves which is relevant and timely, for example. They recognize the nature of the information they need on an ongoing basis and are preparing data for themselves and their staff with the tools they have at hand.

In addition, principals who confidently critique data are not timid around numbers. They do not accept data passively, but compare one data source to another and ask questions of the data, engaging in a substantive way with numbers, that to them, represent the students they know. For principals with these characteristics, data use is an interactive process (Brown & Duguid, 2000; Cousins & Leithwood, 1993; DuFour & Eaker, 1998; Leithwood, Aitken, & Jantzi, 2006). Principals with an understanding of how leaders interact with information will not simply comply with required use of data technology but will leverage it for authentic school improvement.

Education leaders and planners who recognize the qualities present in data-minded educators may thus better identify the capacity for successful use of dashboards in
prospective principals. The qualities which will trigger effective dashboard use, once categorized, can also be cultivated in current school leadership.

**Framework for action.** Teachers as well as principals must trust the data. One means to establish that trust is the framework provided by a Professional Learning Community (PLC) and the development of common assessments. In this section, the research literature of PLCs is briefly summarized. The connection of PLCs to the interaction of principals and dashboards concludes the section.

PLCs are groups of staff (not just leadership) who meet together to discuss problems and solutions, to examine evidence, and to share their knowledge of what works (Boudett, et al., 2005; Copland et al., 2009; DuFour & Eaker, 1998; Huffman & Thomas, 2009; Leithwood et al., 2006). How does leadership organize this collaborative data analysis? What does it look like in practice? The PLC is an approach promulgated by DuFour and Eaker (1998), and emphasizes four key questions educators must ask if they believe all students can learn:

1. What is it we expect them to learn?
2. How will we know when they have learned it?
3. How will we respond when they don’t learn?
4. How will we respond when they already know it?

The PLC description of effective teams, as well as the school organizational procedures to enable those teams, offer a precise outline of school-level actions which frame the collaboration and culture of inquiry (“All Things PLC,” n.d.).

In their discussion of school monitoring systems, Leithwood, et al. (2006) also spent considerable time detailing the PLC. Their text includes the questions which echo Dufour
and Eaker (1998): “What Ought to Be Accomplished?” is the title of chapter 5 (Leithwood, et al, 2006). What follows in that chapter is an extensive treatment of monitoring systems; schools need data access to keep track of the key questions: *What is it we expect students to learn? How will we know when they have learned it?* The culture of inquiry outlined by Copland et al. (2009) or the data improvement process charted by Boudett et al. (2005) are concepts which can exist in a school with effective PLCs whether described by the DuFour and Eaker (1998) or Leithwood et al. (2006).

In many schools, PLCs have been “first-order changes” which will not be “successfully institutionalized in the absence of complementary second-order changes” (Leithwood et al., 2006, p. 18). As the school’s procedures are clarified and communicated, the policies which would support PLCs must be carefully articulated. The opportunity to follow the numerous examples (Boudett et al., 2005; Copland et al., 2009; Huffman & Thomas, 2009; Leithwood et al., 2006) exists, but schools must organize around these collaborative teams. This is the explicit structure described by Wayman, et al. (2013). As educators “institutionalize” these PLC policies, the questions of PLCs (centered on student learning) will become second nature. Data analysis will not seem like a haphazard extra duty but instead an integral part of the routine.

As the structure of the school becomes more clearly focused, staff will relax around these consistent norms and thus have the mental energy for additional data deliberations. In fact, many staff may well be hungry for the opportunity to serve the school at large. Ambitious teachers want to affect student achievement beyond their individual classrooms. In practice, therefore, the subject area PLC concept could serve also as the basis of staff examination of school achievement at large and the operational changes necessary for
improvement. As with the implementation of content area PLCs which Leithwood et al. (2006) discussed, the organizational entity must adapt—its structure and resources—in order for this holistic data analysis to become part of the fabric of the school. The principal must take actions such as addressing a school-wide academic need (e.g., a remediation program) or better organizing the school (e.g., improve the allocation of staff time in order to organize PLCs). The principal sets the stage for school improvement to occur by ensuring that PLCs are functioning effectively. Dashboards facilitate the principal actions described here.

Lessons from Logic Models

A theory-based evaluation based on a theory of change (Weiss, 1995, 1997a, 1997b) relies extensively on participant voices. The "explanatory stories" (Weiss, 1997b, p. 79) of the interview participants provide the strength of the findings in this study, grounding those findings in reality. The logic models based on the findings categorize the elements of the inputs, or resources, and show the interaction of those elements in the functioning of the program. The discussion of program theory and the visual representation of the program's logic (Leeuw, 2003) can be mined for insights. The Phase 1 model, presented in Chapter 4 and discussed earlier in this chapter, will be referenced again, now in comparison to the Phase 2 model. The partial Phase 2 models also presented in Chapter 4 depicted the discrepancies in desired outcomes when considering officially expressed intentions against the reality in practice. In this section, the full Phase 2 model is presented, then compared with the Phase 1 model. Lessons for educators are discussed.

In Figure 20 below, the input of the logic model is defined as people, product, data, and organization. Understanding the relationship of the input through the activity to the output provides trigger points at which state or district leaders who wish to impact the
activity for more effective dashboard use might target their interventions: professional development, data or product improvements, and organizational process changes to enhance the decision making. The outcomes are presented here as ideal outcomes, although as previously described, the reality diverges from the ideal in North Carolina. If a program’s intended outcome differs from the outcome which is being sought in practice, resolving that discrepancy should be a priority. In general, however, Figure 20 below offers a picture of the interplay of related factors which constitute dashboard use, and therefore an opportunity for planners to discuss with precision the point at which an intervention would make a difference.

Figure 20. Complete model of Phase 2 findings.
In order to elicit the output illustrated above, when people engage with their data, as facilitated by a technology product such as a dashboard and in the context of an organization, the factors on the left, the inputs, must be considered. The W.K. Kellogg Foundation (2004) phrases this an "if-then" framework. The next parts of this section describe the people, product, data, and organization with the use of W.K. Kellogg's (2004) "if-then" framework.

**People.** If principals are instinctively analytical thinkers, then they are likely to intuitively use a dashboard well. If they are problem solvers—curious about causes, persistent and motivated to find solutions—then the dashboard will be welcomed and utilized effectively. If principals exhibit a desire for efficiency and a tendency to automate whenever possible, if they are detail-oriented about elements of the problem and the organization of the solution; then the dashboard will function well to facilitate their data analysis and subsequent action. If principals trust data to guide them, but do not rely on data unquestioningly and instead engage and push back as they seek the most appropriate answers for their school, then their interaction with data will lead to effective decision making.

If principals, as leaders of a complex and varied school community, value situational awareness, then dashboards will be viewed as instrumental tools toward achieving that awareness. If principals possess a combination of principal knowledge and data access knowledge, or if they are able to identify and promote this expertise on their campus, then dashboards will be effective tools. If principals possess sufficient assessment and spreadsheet skills, particularly early in dashboard implementations, then they are more likely to leverage the dashboard for school improvement.

**Product, data, organization.** If a technology product is to provide an effective interaction with data, then the product must be more than a collection of parts. If people are
to interact with data in helpful ways, then they must have the rights and permissions necessary to access the data. If data analysis is to occur, then the necessary data must exist in the right format and be accessible by the technology product. If data analysis is to result in effective decision making, then schools must seek staff (whether the principal or someone else) to fulfill the role of data analyst. Regardless, the principal must establish a culture which encourages engagement with data and a structure for staff data analysis.

**Comparing Phase 1 and Phase 2 models.** The model developed from corporate literature and interviews with experts in industries familiar with dashboards is presented again in Figure 21 below. (The Phase 2 model is in Figure 19 above). In both Phase 1 and Phase 2, the activity and the output are similar. The outcomes differ and those differences offer insights to educators; they will be discussed first in this section followed by insights from the inputs on the far left in each model.

![Complete model of Phase 1 findings](image-url)

**Figure 21.** Complete model of Phase 1 findings.
Outcomes. In the corporate context, the expected outcome from the interactive activity of people, data, product, and organization, is analytics. In their conversations about dashboards, expert users and technology developers focus heavily on the human thinking process. Perhaps because the interview participants in this study came from diverse domains, the common denominator of analytics emerged more clearly. It was evident, however, that the business perspective is that the outcome which triggers improved decision making is analytics. If one were to apply the term analytics to education, even though educators rarely use the term, one would describe the outcome both intended and in practice to be analytics for instructional improvements. Additional outcomes in education which appear to be intended, but not in practice, are analytics at the school level for monitoring and evaluation of the school's organization and programs.

Inputs. The inputs in both models (Figures 20 and 21), at the far left, are organized similarly. Yet in the literature, interviews, documents, and observations, differences between Phase 1 and Phase 2 emerged. As discussed in previous sections, articulating the knowledge, skills, and dispositions of strong data users in education, whether dashboard users or not, offers insights for prospective dashboard implementations. A comparison of the two models now offers further lessons.

Certain skills are more prevalent in business than in education. As the technology vendor noted, business experts tend to be more cross-trained. Offering educators some of these specific, concrete skills such as analysis with spreadsheets would enable data users in education to thrive both in the midst of dashboard implementations and later when dashboards are more typical in schools. Successful people in business and successful
educators alike are analytical. They engage with data, ask questions confidently of data, and seek answers in the data which they understand to be authentic for their context.

The most striking lessons may emerge from the discussion of the product, the data, and the organization; areas where the professional context of educators is either vastly different or educators simply have no experience. Educators, particular planners with responsibility for procuring dashboard technology, can profit enormously by understanding from the business world what factors make a dashboard an effective tool. From a drill-down capacity to the use of the dashboard as a communication tool within the organization, educators unfamiliar in their own profession with this technology should benefit from the long history of use and more robust technical research which exists in the domain of business. Understanding data as instrumental to the interaction is a logical corollary to perspectives of the technology tool. Many educators make assumptions about the quality and specificity of their data; assumptions which can then lead to disappointment regarding the success of the data analysis. In addition, data visualization is an enormously important field largely untapped in education technology for school improvement purposes. Educators should not wait to engage with data visualization. As they advance along the data technology continuum by incorporating dashboards into their daily work, educators should profit also from the new frontier in business analytics: data visualization.

Finally, as part of adopting the terminology of dashboards, educators should seek to understand their own appropriate Key Performance Indicators (KPIs). Educators can benefit from the literature which develops strategies based on identifying these metrics and developing a dashboard to facilitate their integration into the organization’s goals. Another major lesson to learn from peers in the business world is the need for solid processes for
action; a framework such as Six Sigma, Deming's principles for process improvement, or a program evaluation approach to school organization. Educators who understand the intricacies of their own profession can benefit from a comparison of business processes to the education context.

Lessons from the Theory-Practice Gap

In this section, several suggestions resulting from the case study of North Carolina are discussed. These findings represent insights for states or districts seeking to understand dashboard use in their schools or facing dashboard implementation.

Strive for a dashboard. The whole product complexity and brand confusion Home Base stakeholders experience in North Carolina represent a larger issue. Home Base currently appears to school-based users as an interface offering a single sign-on to multiple software products rather than as a dashboard presenting a coherent picture of school data. One lesson for North Carolina's state planners may be that the brand confusion will dissipate if Home Base truly does become a dashboard; a tool which integrates streams of data. Ultimately, much of the potential for school improvement is lost without the power of a dashboard. For example, situational awareness is enabled by a dashboard, not by a single sign-on interface.

Demands for school accountability have the potential to degrade school improvement efforts (Copland, et al., 2009; Konold & Kauffman, 2009; Marzano, 2009). Increased data collection can consume leaders to the exclusion of analysis or action. However, if school leaders leverage the data technology provided in the wake of increased accountability, internal improvements may emerge from the external demands (Knapp & Feldman, 2012). Leveraging data technology means seeking a dashboard; setting a higher bar for knowledge
utilization (Cousins & Leithwood, 1993) than simply providing single sign-on access. The opportunities a dashboard can offer schools further include access to (and integration of) multiple data streams (Bernhardt, 2004). Principal research has found that important data sources remain out of reach for many school leaders (Shen et al., 2012) but that principals value a school-wide view (Coburn & Talbert, 2006). Dashboards have the power to allow principals to tap into varied data sources for the view of school operations and programming that they must have to lead effectively.

The potential to have a dashboard in North Carolina still exists. The SchoolNet product appears in previous promotional materials as a dashboard; as a tool which offers principals other than assessment data. Educators in general support more holistic data-based decision making and a view of the whole child. However, not only are school accountability priorities driving data-based decision making (with demands for analysis of assessment data) but the tool at this point also offers little else. For North Carolina at this time, the implementation continues, yet there is still time for conversation about the ultimate functioning of Home Base; will it be a dashboard?

**Implementation.** The state-wide technology implementation and associated difficulties factors heavily in the discussion of dashboards for principals in North Carolina. The complexity of the technology undertaking—"disruptive technology" per the Summary Information Technology Plan (Price, 2012, p. 25)—has not surprisingly led to a series of implementation issues. The confusion previously described is one factor; another is the varied implementation sites across the state (including hardware and connectivity variety), and the unevenness of the technology's performance is another. Asking questions of even experienced and data-minded principals results in conversation about the implementation
itself. Evaluating the implementation was not the goal of this research, although such an evaluation would be a logical step for the state. Instead, the focus here was on program theory, as a way of articulating how the effects are expected to be obtained (Weiss, 1997a).

Clarity with program theory allows stakeholders a look at the chain of events, thus a better understanding of the workings of the program itself. Weiss (1997a) argues that for a future implementation evaluation and the eventual study of a program’s impact, an understanding of program theory is essential. This research increases that understanding by describing the nature of various stakeholder roles in North Carolina: DPI planners, the technology vendor, district-based support staff, school-based support staff, and principals at different levels from around the state. As described in an earlier section, the logic model sheds light on key discrepancies between theory and practice, offering a starting point as evaluators first clarify the expected outcomes. Involving stakeholders, clarifying program design, exploring program reality; these are elements of an evaluability assessment (Whooley, 2004) offer North Carolina, or other states in a data technology implementation, specific steps toward future evaluations.

**Time for a program evaluation framework.** With an approach to dashboards through the lens of program evaluation in this study, the researcher articulates a theory of change via a logic model. Program evaluation is also however a large part of what principals do as the leaders of their schools. Typically, principals do not speak the language of program evaluation. Referring to logic models evinced a certain awkwardness in interviews, and the researcher quickly reduced the term to *model* to convey the idea of mapping concepts or the workings of programs or initiatives, which was more intuitively clear, albeit not a familiar activity. Principals should speak the language of program evaluation, nonetheless. The
introduction of dashboards and the potential for more sophisticated analytics is the opportune moment to teach this language.

Strong principals are likely to instinctively grasp the importance of program evaluation as a framework. High School Principal A, for example, who responded to a district requirement to conduct classroom walk-throughs by establishing a logical schedule and a data collection form tailored to his school's needs, would understand the need to frame his walk-through effort as a program. He and his staff could articulate the need, the theory, the process by which they work to accomplish their goals, and the impact or efficiency of the walk-throughs. Strong principals are organized and want to understand how their schools function; they desire efficiency and minimal wasted effort; these qualities and desires mesh well with program evaluation. The lessons from this study's focus on the reality of dashboard use, or possible dashboard use, support the development of program evaluation capacity among educators.

**Recommendations**

In this section, specific steps are recommended for educators. First, a prescription for explicit professional development describes tangible action steps. Next, higher level recommendations are presented. Finally, short term, intermediate, and long range recommendations for states such as North Carolina, which are experiencing dashboard implementations, are described.

**Concrete Action Steps**

1. Principals need spreadsheet skills. The dashboard concept is nascent in education, which means for the foreseeable future, principals accomplished with the use of Excel will more expertly analyze their data. More importantly, however, spreadsheet skills engender a
connection to the data. Without a solid connection to the data the influence to act is weaker.

2. Principals need assessment skills. Even if the heavy focus on student achievement as measured by tests will eventually be balanced by other data streams, it is vital to current school accountability measures. Assessment will naturally remain important to instructional data-based decision making, and educators often lack necessary understanding of the parameters of assessment data (e.g., the implications of item analysis data).

3. Principals need to understand analytics in order to benefit from the business literature which addresses dashboard use in that domain. Analytics for educators would help them make more effective data-based decisions.

4. Principals need program evaluation capacity. As with corporate vocabulary, an understanding of terminology increases the benefit from program evaluation research literature. In addition, program evaluation offers a vehicle for the school improvement many principals are intuitively attempting.

5. Principals need instruction in process improvement. In the corporate environment, a discussion of dashboard use is closely tied to quality processes. Schools have the same needs as businesses for excellence in program implementation, and effective process improvement in their operational management.

**Broader Action Steps**

1. Principals need to take responsibility for the school's data culture. The principal must ensure the effective functioning of a Data Team, and although the principal may or may not be a school's primary data analyst, the principal can ensure that the role of data
analyst is filled by someone on staff. Principals need to establish a culture of constructive data analysis and evidence-based programmatic and instructional changes on their campuses.

2. Principals need to "live in" the data. Situational awareness is facilitated by an effective dashboard, and a strong engagement with data leads to motivation to act.

3. Principals need to ensure high-functioning PLCs which are key for instructional data-based decision making and routinizing (Bain, 2007) excellence across the building.

4. Principals need dashboards which offer data visualization. People are motivated by a visual presentation of data, the volume of data streaming into the principal's office is overwhelming, and principals lack the time necessary to organize and repackage data for insights. Data visualization tools meet these requirements.

**Recommendations for Dashboard Implementations in Education**

In this section, recommendations are discussed in terms of planning by states or districts. Data systems are an enormous investment for schools (Wayman & Cho, 2009), and states must seek to leverage the full potential of the data technology. Ranging from short-term strategies to long-range vision, these recommendations describe an approach to implementation which offers clarity about obstacles and opportunities.

**Plan professional development for principals.** Dashboards will eventually become a fixture in education. During the implementation period, successful principals need spreadsheet skills. In time, if tools such as Home Base in North Carolina become more developed and nuanced, the importance of spreadsheet use as a separate skill will recede. Planning professional development for data analysis, through the vehicle of Excel, allows the dashboards to serve an immediately useful role in data-based decision making. Easing the
discomfort some principals feel toward interactions with data by offering them spreadsheet skills will also further the long-term cause of data use.

States need to consider a needs assessment specifically for their schools' principals. Leadership qualities as well as technology adoption capacity for the use of dashboards as a revolutionary tool in data-based decision making can be identified and quantified. The research literature offers much in the way of describing or measuring readiness for individual and organizational change (Fullan, 2001; Lehman, Greener, & Simpson, 2002; Stoll, 2009), as well as the potential for acceptance and use of technological advances (Brockmeier, et al., 2005; Clausing & Holmes, 2010; Corn, 2010; Lin & Hsieh, 2012; Shen, et al., 2012; Smarkola, 2011; Straub, 2009). Readiness skills identified in this research include expertise with spreadsheets and assessments, or an understanding of terminology such as analytics, as well as the varied dispositional characteristics.

A map for readiness skills may exist in principal leadership as described by Marzano, et al. (2005), which offers a means for state or district planners to connect known principal responsibilities to dashboard use. The concept of situational awareness has been discussed in this chapter. States should recognize that the overlap of respected educational research with a dashboard concept such as situational awareness provides a point of entry into dashboard use for professional educators. In addition, other principal responsibilities such as monitoring and evaluating and order are also closely tied to principal data use. Professional development can impress upon principals that dashboards make the monitoring of school data a routine process, with principal time and energy thus reserved for taking action. Evaluating, as discussed previously, can also become a normal exercise in a principal's professional life.
**Clarify the outcomes.** A program logic model functions to explicate program theory. In this study, the program theory is how dashboard use improves decision making in schools. With the logic model, planners (educators implementing dashboards) can understand the sequence of events and operationalize the concepts which power the program (Weiss, 1997a). Stakeholders benefit from confronting discrepancies between their stated outcomes and the actual expected outcomes of the program (Crane, 2010; Wholey, 2004). In this case, educators should come to consensus that desired outcomes of dashboard use include principal-level action and not simply instructional data-based decision making. Only then can the most appropriate program plan be implemented to elicit those outcomes.

**Expand the data sources.** Like education around the country, North Carolina is focused on testing, assessment data, and instructional data-based decision making. Additional KPIs would improve principal decision making. Many principals desire these additional metrics. Educators who view their achievement data as the only important metric are analogous to the businesses referenced by Kaplan and Norton in 1992; businesses which base decision making on past financial measures rather than by anticipating future challenges. A school’s comprehensive measures would likely include student attendance and discipline data as well as teacher professional development and turnover data, for example. Examples of the various data sources (not solely limited to student achievement) are Bernhardt’s (2004) four measures: demographics, perceptions, student learning, and school processes. The metrics chosen to appear on the dashboard should align with the priorities of the organization. A dashboard should include additional streams of data and therefore enable principals to make more effective school-wide data-based decisions.
**Develop dashboards for strategic use.** Schoolnet is advertised outside the North Carolina context as a more holistic product than is currently in use in the state. Clearly, a principal's dashboard has the potential to more closely resemble a typical corporate dashboard, or a sophisticated management tool representing the overall strategic goals of the organization.

Dashboard elements can be summarized in two ways. First, the user experience is most effective when the interface follows basic design principles. Insights by dashboard design experts (Allio, 2012; Eckerson, 2005; Few, 2013) were reviewed in a previous chapter, and industry experts offered insights reported earlier as well. State and district leadership should become familiar with those basic design principles as a means to effectively working with the technology vendors who market their products to educators.

State and district leadership should further envision dashboards as a key analytical tool. While dashboards occasionally function primarily for monitoring as opposed to analysis (Power, 2010; Velcu-Laitinen & Yigitbasioglu, 2012), the capability exists for “solving nonroutine problems through knowledge of the past (what has happened), the present (what is happening), and the future (what might happen)” (Huang, et al., 2011). Data visualization promises much for this powerful use of data analytics. In order to facilitate that use, visualization technology emerges from the insights of cognitive fit theory (Velcu-Laitinen & Yigitbasioglu, 2012) which addresses “the fit between an individual’s decision-making skills, the information presentation format and the task at hand” (p. 42). An integrated platform or a single sign-on is necessary but insufficient; an unfortunately limiting approach when powerful potential exists for dashboard use. States with the vision of a dashboard for their educators need to see the value of the whole and not lose sight of key dashboard concepts.
Seek evaluative capacity. Program evaluation as a concept is foreign to educators. They do not discuss logic models, for example, or program planning. As a companion to a data technology implementation, states need evaluation capacity building. Desired principal outcomes center on the development of an evaluative capacity which enables principals first to manage their buildings such that highly effective instruction is made possible, and second, to plan and evaluate school-wide programs. These two outcomes contribute to school improvement (Bryk, et al., 2010).

Guerra-López and Toker (2012) argued for the systematic evaluation of schools and education activities as a method for improving performance, and described a process for evaluating the impact of programs using a framework (the Impact Evaluation Process) developed by Guerra-López in 2007. In their study, these authors followed a seven-step process in collaboration with the school-based staff to establish a structure for ongoing evaluation of school initiatives (as opposed to a one-time program evaluation). They began with the School Improvement Plan, a familiar document at most schools, created by a faculty and administrative team with goals, strategies for attaining those goals, and outcome measures for the school as a whole. A critical step included in the study was articulating the linkages between a school’s vision or expectations and measurable indicators, with appropriate tracking of what Guerra-López and Toker called “enroute performance indicators” (p. 225).

Unfortunately for the school in this study, the anticipated information technology system did not materialize. Guerra-López and Toker pointed out the value of such a system to facilitate the evaluation they promote, and admitted the significant challenge faced by the school they studied without such a tool. States such as North Carolina face the opening of a
window (Kingdon, 2002) in that a technology system—a potential dashboard—could facilitate the type of evaluation promoted by Guerra-López and Toker (2012). Substantive, systemic changes in the internal workings of a school are a route to improvement which may be prompted by external demands and made possible by a dashboard.

**Future Research**

This study explores data technology in education, offering several pivotal points at which future research would extend the findings in meaningful ways. This section discusses three such points. First, readiness assessments targeted specifically to principals would provide concrete and immediate help to state and district planners. Next, technology research could offer more specific understanding of how educators interact with their data tools and how the products could evolve to serve educators best. Finally, the focus of this research was the school, as the "unit of knowledge use and change" (Cousins & Leithwood, 1993, p. 306) for educational reform. As leader of the school, the principal is the gatekeeper for effective data-based decision making and school improvement. A research focus on principal use of a dashboard is warranted.

**Readiness Assessments**

Data use research has previously pointed out that a better understanding of the linkages in the causal chain will improve data-based decision making (Coburn & Turner, 2012). Future research can now leverage this study, which describes those linkages, by developing assessments of readiness for principals. Districts and states need access to tools they can readily use to diagnose professional development needs of their staff. The logic model suggests trigger points for assessment, and articulates dashboard readiness qualities in ways that principals do not describe with clarity when simply asked. Practitioners cannot
always explain precisely what they need for new technology, because their understanding is based on previous technology. Nor can practitioners necessarily perceive the distinction between what they believe they want and what they actually need or what the organization should want for them. This distinction between want and need (Conner, Jacobi, Altman, & Aslanian, 1985) can greatly improve the ability of state leadership to prioritize professional development. A further goal is to economize by providing the essential knowledge or skills principals need for effective use and not what principals ultimately unfamiliar with the new technology think they need.

**Technology: Products and Interactions with Products**

Future research could also develop data visualization for educators; tailored products not only for schools but for principals specifically, and could further explain how decision making is impacted by the technical design of dashboards or data presentation tools. Excel, a basic tool in most workplaces, has the potential to prompt transformative change in education data use. Participants in this study strongly suggested that spreadsheets foster insights and action in ways that other data reporting (e.g. PDF files) could not. Teasing out more nuance from this seemingly simple point could offer educators a practical, affordable path to more sophisticated data use with great impact. In addition, the findings of this research present a preliminary understanding of the user and the user's context, a starting point for future "science that designs and evaluates artifacts to help users do their tasks" (Carroll & Campbell, 1989, p. 256). The science of technology design will find deep and varied needs for investigations into educators' use of tools for meaningful data-based decision making.
Focus on Principals

Finally, the role of the principal as a leader of a complex organization merits attention. The possibility of a dashboard designed for a principal in the sense of a dashboard for a Chief Executive Officer (CEO) offers an opportunity to focus attention on a school as a whole. Business experience and research do provide lessons for educators (Hallinger & Snidvongs, 2008), and at the moment of dashboard adoption, the time for attention to the principal as CEO is appropriate. The new efficiencies of dashboards in education offer an entry point into improving the strategic management of schools due to more effective principal data-based decision making.

Conclusion

Because data access may be perceived by principals as overwhelming or irrelevant rather than helpful (Wayman, Spikes, & Volonnino, 2013), data access does not guarantee effective data use. The data-based decision making literature has largely focused on teacher use of data, considering less often data-based organizational improvements for the school as a whole with the inherent focus on the role of the principal. The purpose of this study was to articulate the theory of change (Carman, 2010; Weiss, 1997a) which underlies the connection between accessing data via a dashboard, and the successful use of data to inform decision making by K-12 principals in their schools. This study's research question asked what knowledge, skills, and dispositions contribute to effective use of data dashboards by principals for school improvement. To answer that question, basic interpretive qualitative methods (Denzin & Lincoln, 1994; Merriam, 2002) were first used to outline the nature of dashboard use according to experts in industries where dashboards have a longer history and a more robust data technology literature base than in education. Then, with a case study
design (Creswell, 2007; Merriam, 1988; Stake, 1995) and a focus on a data dashboard implementation in North Carolina, this study elicited program theory from North Carolina stakeholders. Data from interviews, observations, and documents were analyzed to articulate a theory of change and create (a) a logic model (a visual diagram) of how the dashboard is expected to facilitate data access and result in effective decision making, as well as (b) a logic model illustrating the theory-practice gap.

Results of the study led to recommendations specifically for principals, ranging from developing spreadsheet skills to leveraging dashboards for situational awareness (Few, 2013; Marzano, Waters, & McNulty, 2005). In addition, the findings suggest that education planners should seek a true dashboard and refuse to settle for an interface offering a single sign-on to multiple software products. Further, schools need a framework for the action subsequent to data-based decision making. In the discussion of these findings, the study highlights the connection of Professional Learning Communities (PLCs) to principals and dashboards and offers insights from the business research literature about process improvement. This study has implications not only for the professional development of principals but also for the improvement of dashboard technology implementations, and for an expanded understanding of the potentially transformative impact of dashboards on decision making.
REFERENCES


APPENDICES
Appendix A

Copyright Permission for Figure 3

Bernhardt, Vickie (VBernhardt@csuchico.edu)
9/9/13

Dear Kathryn,

Thank you for your request to use the multiple measures of data graphic in your dissertation. You may use it. Lynn Swaim will send you a camera ready version.

When you reference it, I would appreciate it if you used the most recent text: *Data Analysis for Continuous School Improvement*, Third Edition. Attached is a flyer with information. (My publisher just changed this summer.)

Please keep in touch and let us know how it goes.

All my best,

Victoria L. Bernhardt
Executive Director
Education for the Future
400 West First Street
Chico, CA 95929-0230
530-898-4482 fax 4484
vbernhardt@csuchico.edu
http://eff.csuchico.edu
Appendix B

Copyright Permission for Figures 7-11

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Appendix C

Phase 1 Communications

Request for Contact Email

Dear _____,

I am a doctoral student in the Educational Leadership and Policy Analysis program at North Carolina State University in Raleigh. Could you suggest someone from (the Home Base project / the North Carolina Home Base implementation team) who could give me 45 minutes for a conversation about Home Base?

The goal of the first phase of my dissertation study is to present an understanding of the essential knowledge, skills, and dispositions of principals who use dashboards for school improvement decision making. I was a classroom teacher for 20 years in Texas, Georgia, and North Carolina and worked on several school-wide program implementations in each position. My research interest centers on data-based decision making, particularly the use of data dashboards for decision making in K-12 schools.

I would be happy to share more information with you about my research intentions, and also share the results when I conclude the project. I will send you the questions for the planned interview in advance if you wish.

Again, if you could recommend the best contact in your organization, I would very much appreciate it. Please do not hesitate to ask any questions you may have. You can reach me via email or at the phone number below. Thank you very much for your consideration.

Kathryn Marker
Participant Invitation Email

Dear ______,

I am a doctoral student in the Educational Leadership and Policy Analysis program at North Carolina State University in Raleigh. (DPI or Person lead) suggested I contact you. Would you be willing to meet with me / speak with me on the phone for about 45 minutes in (March)?

The goal of the first phase of my research is to present the essential knowledge, skills, and dispositions of principals who have used dashboards for school improvement. I was a classroom teacher for 20 years in Texas, Georgia, and North Carolina and worked on several school-wide program implementations in each position. My research interest centers on data-based decision making, particularly the use of data dashboards for improvement in K-12 schools.

I would be happy to share more information with you about my research intentions, and also share the results when I conclude the project. I will send you the questions for our interview in advance if you wish.

Please do not hesitate to ask any questions you may have. You can reach me via email or at the phone number below. Thank you very much for your consideration.

Kathryn Marker
Confirmation Email

Dear _____,

Thank you very much for agreeing to speak with me. I would like to suggest the following dates: (i.e. “at any time on Monday, Tuesday or Wednesday next week or the following week”). What is the best number to call? / May I meet you in your office? I expect our interview to last 45 minutes.

Would you mind if I recorded our conversation? It would greatly facilitate my data analysis if I could do so, but I will follow your wishes in the matter.

Please let me know if you would like me to consider your identity as confidential. I can refer to you in the results with a pseudonym and ensure the description of your school is such that it cannot be identified. I am appreciative of your willingness to participate in this study, and would like to honor your preferences.

(As you requested, please find attached the interview questions I plan to ask.)

Kathryn Marker
Appendix D

Phase 2 Communications (Educators outside North Carolina)

Request for Contact Email

Dear _____,

I am a doctoral student in the Educational Leadership and Policy Analysis program at North Carolina State University in Raleigh. In (publication) I read about (the data dashboard tool) used in (school district). Could you suggest a principal in (school district) who is knowledgeable about the (specific school improvement) process?

The goal of the first phase of my research is to present the essential knowledge, skills, and dispositions of school leaders who have used dashboards for school improvement. I was a classroom teacher for 20 years in Texas, Georgia, and North Carolina and worked on several school-wide program implementations in each position. My research interest centers on data-based decision making, particularly the use of data dashboards for decision making in K-12 schools.

I would be happy to share more information with (district) about my research intentions, and also share the results when I conclude the project. I will send you the questions for the planned interview in advance if you wish.

Please do not hesitate to ask any questions you may have. You can reach me via email or at the phone number below. Thank you very much for your consideration.

Kathryn Marker
Participant Invitation Email

Dear _____,

I am a doctoral student in the Educational Leadership and Policy Analysis program at North Carolina State University in Raleigh. In (publication) I read about the data dashboard tool used in (school district). (Superintendent or other lead) suggested I contact you. Would you be willing to meet with me / speak with me on the phone for about 45 minutes in (suggested time frame)?

The goal of the first phase of my research is to present the essential knowledge, skills, and dispositions of principals who have used dashboards for school improvement. I was a classroom teacher for 20 years in Texas, Georgia, and North Carolina and worked on several school-wide program implementations in each position. My research interest centers on data-based decision making, particularly the use of data dashboards for improvement in K-12 schools.

I would be happy to share more information with you about my research intentions, and also share the results when I conclude the project. I will send you the questions for our interview in advance if you wish.

Please do not hesitate to ask any questions you may have. You can reach me via email or at the phone number below. Thank you very much for your consideration.

Kathryn Marker
Confirmation Email

Dear _____.

Thank you very much for agreeing to speak with me. I would like to suggest the following dates: (i.e.” at any time on Monday, Tuesday or Wednesday next week or the following week”). What is the best number to call? / May I meet you in your office at (school)? I expect our interview to last 45 minutes.

Would you mind if I recorded our conversation? It would greatly facilitate my data analysis if I could do so, but I will follow your wishes in the matter.

Please let me know if you would like the data to be kept confidential. I can refer to you in the results with a pseudonym and ensure the description of your school is such that it cannot be identified. I am appreciative of your willingness to participate in this study, and would like to honor your preferences.

(As you requested, please find attached the interview questions I plan to ask.)

Kathryn Marker
Dear _____,

I am a doctoral student in the Educational Leadership and Policy Analysis program at North Carolina State University in Raleigh. I am contacting you because (your county) has piloted the North Carolina Home Base technology. Could you suggest a principal in (school district) who could speak with me about the use of Home Base?

The goal of the first phase of my research is to present the essential knowledge, skills, and dispositions of North Carolina principals who use Home Base for school improvement. I was a classroom teacher for 20 years in Texas, Georgia, and North Carolina and worked on several school-wide program implementations in each position. My research interest centers on data-based decision making, particularly the use of data dashboards for decision making in K-12 schools.

I would be happy to share more information with (district) about my research intentions, and also share the results when I conclude the project. I will send you the questions for the planned interview in advance if you wish.

Please do not hesitate to ask any questions you may have. You can reach me via email or at the phone number below. Thank you very much for your consideration.

Kathryn Marker
Participant Invitation Email

Dear _____,

I am a doctoral student in the Educational Leadership and Policy Analysis program at North Carolina State University in Raleigh. I am contacting you because (your county) has piloted the North Carolina Home Base technology. (Superintendent or other lead) suggested I contact you. Would you be willing to meet with me / speak with me on the phone for about 45 minutes in (suggested time frame)?

The goal of the first phase of my research is to present the essential knowledge, skills, and dispositions of principals who have used dashboards for school improvement. I was a classroom teacher for 20 years in Texas, Georgia, and North Carolina and worked on several school-wide program implementations in each position. My research interest centers on data-based decision making, particularly the use of data dashboards for improvement in K-12 schools.

I would be happy to share more information with you about my research intentions, and also share the results when I conclude the project. I will send you the questions for our interview in advance if you wish.

Please do not hesitate to ask any questions you may have. You can reach me via email or at the phone number below. Thank you very much for your consideration.

Kathryn Marker
Confirmation Email

Dear _____,

Thank you very much for agreeing to speak with me. I would like to suggest the following dates: (i.e.” at any time on Monday, Tuesday or Wednesday next week or the following week”). What is the best number to call? / May I meet you in your office at (school)? I expect our interview to last 45 minutes.

Would you mind if I recorded our conversation? It would greatly facilitate my data analysis if I could do so, but I will follow your wishes in the matter.

Please let me know if you would like the data to be kept confidential. I can refer to you in the results with a pseudonym and ensure the description of your school is such that it cannot be identified. I am appreciative of your willingness to participate in this study, and would like to honor your preferences.

(As you requested, please find attached the interview questions I plan to ask.)

Kathryn Marker
Appendix F

Interview Protocol: Phase 1 industry experts

Hello. Thank you for speaking with me. Is it still acceptable for me to record our interview?

1. Could you give me a snapshot of your experience with the data technology?

2. How does the interface look in the best types of dashboards? (Will the end users be able to customize the interface?)

3. In this study, I am concentrating on the role of the principal in a public school, as a leader of school-wide programming and overall building management. Could you walk me through the process that a manager would use with a dashboard as a key tool for organizational management? (draw parallels between corporate use and school principal use as needed)

4. What would a manager need to know and do, in order to use data technology successfully for planning, or for evaluating the organization? (Can you walk me through a scenario you can imagine where a manager relies on dashboard technology?)

5. How would you complete the following sentence? “Using a dashboard is like using _____ because _____.”

6. Is there any type of training you see as invaluable for managers in order for them to fully utilize the dashboards as a professional tool?

7. Are there any institutional characteristics or resources you perceive as essential?

8. Can you describe any leaders you expect would be unable or unwilling to make full use of data dashboard technology?

9. Is there anything else that we haven’t covered that you would like to share?
10. Finally, do you have any recommendations for me of other experts who might have expertise and experience to help me shape the picture of data dashboard use?

I appreciate your time. It is my intention to further the effective use of data dashboards for school improvement, and it was important to speak with you because you have direct knowledge of dashboard technology. Do you have any questions for me? Thank you again.
Appendix G

**Interview Protocol: Phase 2 principals experienced with dashboard use**

Hello. Thank you for speaking with me. Is it still acceptable for me to record our interview?

1. Could you give me a snapshot of your professional experience?

2. Walk me through the process that enabled (your school) to use the (name of data tool) to implement (the specific changes) you have made.

3. Is the use of (this tool) part of a long range technology plan in (your district)?

4. What is the technology support like in (your district)?

5. How do you incorporate the use of (this tool) on a daily basis?

6. Can you give me an example of a planning decision you made recently which was prompted by information you gained from (this tool)? *This is a key question; probes or follow-ups will be essential here.*

7. What would a principal need to know and do in order to effectively use the data from the dashboard?

8. How would you complete the following sentence? “Using data dashboards is like using _____ because _____."

9. Have you had any professional development you see as invaluable for this work?

10. Are there any school or district resources you think have been essential?

11. Why do you think other schools have been slower to move in the direction of using tools like (this one)?

12. Can you describe any principals you imagine would be unable or unwilling to make successful use of (this tool)?
13. Is there anything else that we haven’t covered that you would like to share?

14. Finally, do you have any colleagues you would recommend that I speak with who might also have expertise and experience to help shape the picture of data dashboard use?

I appreciate your time. It is my intention to further the effective use of data dashboards for school improvement, and it was important to speak with you because you have played an integral role in that process at (school).

Do you have any questions for me? Thank you again.
Appendix H

Interview Protocol: Phase 2 North Carolina vendor / DPI leadership

Hello. Thank you for speaking with me. Is it still acceptable for me to record our interview? And you do not mind being identified in my paper, is that correct? (You had asked that your identity be considered confidential, is that correct?)

1. Could you give me a snapshot of your experience with the North Carolina Home Base project?

2. How will the Home Base interface look? (Will the end users be able to customize the interface?)

3. In this study, I am concentrating on the role of the principal. Could you walk me through the process that a principal would use with Home Base as a key tool for organizational management of the school? (possible segue from classroom use to principal use: How might a principal coach teachers on their use of Home Base for classroom-based data analysis?)

4. What would school principal need to know and do to use data Home Base for planning or evaluating school-wide programs? (Can you walk me through a scenario you can imagine where a principal relies on Home Base information for management of the school?)

5. How would you complete the following sentence? “Using Home Base is like using _____ because _____.”

6. Is there any professional development you see as invaluable for school principals in order for them to fully utilize the Home Base for school planning?

7. Are there any institutional characteristics or resources you perceive as essential?
8. Can you describe any leaders you expect would be unable or unwilling to make full use of Home Base as it is designed?

9. Is there anything else that we haven’t covered that you would like to share?

10. Finally, do you have any recommendations for me of principals (perhaps in another state) who might have expertise and experience to help me shape the picture of data dashboard use?

I appreciate your time. It is my intention to further the effective use of data dashboards for school improvement, and it was important to speak with you because you have direct knowledge of Home Base.

Do you have any questions for me? Thank you again.
Appendix I

**Interview Protocol: Phase 2 North Carolina principals**

Hello. Thank you for speaking with me. Is it still acceptable for me to record our interview?

1. Could you give me a snapshot of your professional experience?

2. Walk me through the process of adjusting to the use of Home Base.

3. What is the technology support like in (your district)? Here at (your school)? Have you had any technical difficulties with Home Base?

4. How would you describe your use of Home Base on a daily basis?

5. Can you give me an example of a planning decision you made recently which was prompted by Home Base information?

6. Have you had any professional development you see as invaluable for this work?

7. Are there any school or district resources you think have been essential?

8. What do you think makes the use of Home Base difficult or easy?

9. Can you describe the type of principals you imagine would struggle to make successful use of Home Base?

10. Is there anything else that we haven’t covered that you would like to share?

11. Finally, do you have any colleagues you would recommend that I speak with who might also have expertise and experience to help shape the picture of data dashboard use?

I appreciate your time. It is my intention to further the effective use of data dashboards for school improvement, and it was important to speak with you because you have played an integral role in that process at (school).
Appendix J

Informed Consent Documents

Interview Participants

North Carolina State University

INFORMED CONSENT FORM for RESEARCH

School Improvement Strategies in North Carolina: Using Data Tools Effectively

Kathryn Marker, Ph. D. candidate
Dr. Tamara Young, Faculty Advisor

You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher named above.

The overall purpose of this research is to explore the knowledge, skills, and dispositions needed in school principals for effective use of North Carolina's new data tools in public education. It is hoped that results will aid school districts in planning professional development, inform the use of existing or new surveys to assess readiness, and contribute to the school improvement literature.

If you agree to participate in this study, you will be asked to speak with me in person for 45 minutes. I will come to your campus or we can meet in a neutral location such as a coffee shop, whichever you prefer. After I have analyzed the data I would be glad to share the results with you, but you are not obligated to participate in any way after the interview.

I do not foresee any risks to you (personally or professionally) if you agree to participate in this study.

Because you have experience as a public school administrator, it is important that researchers hear your voice. By participating in this study, you are sharing your expertise and informing the planning for helping future administrators use data tools effectively. There will be no personal benefit to you, but the academic community will benefit through improved understanding of your job.
The information in the study records will be kept confidential to the full extent allowed by law. Data will be stored securely on my personal computer or in a file cabinet in my home office. No reference will be made in oral or written reports which could link you to the study. You will NOT be asked to write your name on any study materials so that no one can match your identity to the answers that you provide.

You will not receive any compensation for participating in this study.

If you have questions at any time about the study or the procedures, you may contact me, the researcher (Kathryn Marker) at 919.XXX.XXXX or xxxxxxxx@ncsu.edu.

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919/515-4514).

Consent To Participate

“I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled.”

Subject's signature ________________________________ Date _________________

Investigator's signature ____________________________ Date _________________
Appendix K

Document Analysis

1. Title of document:
2. Type of document:
3. Date retrieved:
4. Retrieved from:
5. Author (title, organization):
6. Intended audience:
7. Description of references to data technology (terms used, phrases which denote meaning attached to the term):
   
8. Use or expected use described or promoted:
Appendix L

Observations

1. Date, time, and location:

2. Title of meeting or presentation:

3. Details of presenter(s):

4. Details of audience:

5. Sketch of room:

6. Agenda of activities with time:

7. Presentational data:

8. Reactions of audience:
Appendix M

Codebook: Phase 1 (interviews 1-5)

Code Name/Label, Definition, "Example"  (DeCuir-Gunby, 2011)

- **actionable insights** = nature of decision-making possibilities suggested by data
- **analytics** = importance, explanations, limitations "using analytics to make a difference makes a lot of sense. I saw a lot of people making decisions using something else."
- **asking questions of the data** = how to approach data, appropriate questions for users to ask "He's teaching people: What to look for in their data and What to do with what they find."
- **business processes** = strategic planning / work flow "a dead-end will be hit and people throw their arms up and say, "I tried". There's no mitigation plan. If we’ve done one thing and it’s not working, well, what else can we do?"
- **dashboard design** = technology of design (color, shapes, diagrams) "I see the data visualization as a way to be able to summarize vast quantities of information, being able to explain things so that they are interpretable a lot faster"
- **data privacy** = concerns about misuse of data "W is hearing the concern about data privacy. The solution is to put rules and processes into place. Recommendation: make comparisons to healthcare and finance, where rules and processes can prevent misuse."
- **data processes** = preparing data for analysis "In health care, you “risk-stratify” your patients. This enables you to normalize your data. With the help of the software, you toss out outliers, put the “expected” over the “actual”..."
- **development of users** = what users need in terms of training or dispositions "They need to be able to do a number of different things. They need to understand the context in which - they need to understand how their business operates. They need to understand the data that they need to answer the business question."
- **drill down** = in data technology, ability for the user to see summary vs. detail (opposite of "roll-up") "There’s 5 areas and they're not doing well in two of them. The indicators allow them to drill very quickly into what's going on in those two areas. And, from there, you would want to select for one particular key performance indicator."
- **health care** = examples from the domain of health care "HEDIS (heed us)= healthcare effectiveness data and information set = national standards for healthcare effectiveness --put out by National Committee on Quality Assurance (QA)"
- **individual power** = individual ability to take action "By putting the drill down capability in the dashboard, from the very high level all the way down to, in our case,
to the individual patient, the individual encounter, you really empower the end user to actually make a meaningful decision.

- **interaction: people and data** = discussion of the interface between users and their information "I see the data visualization as a way to be able to summarize vast quantities of information, being able to explain things so that they are interpretable a lot faster"

- **participant story** = interview participant's personal story "I can't say that I woke up one morning and said that I wanted to be a data scientist analytics guy. It sort of evolved."

- **purpose** = the point to the data analysis/analytics "They were just basically trying to manage the health of a population."

- **quality indicators** = KPIs, metrics; standards which measure / identify quality in a domain "What are the data the drive the business, what are the metrics that drive the business, who owns those metrics, how are they defined, where are the data coming from."

- **statistical/process control** = terms and concepts related specifically to statistics or process "statistical process control. All that Deming and Duran and Shewhart stuff. What’s the common cause variation? What's the special cause variation?"

- **types of users** = dispositions, roles, experiences which can categorize users "problematic mindset: mindset of producing reports instead of analysis."
Appendix N

Codebook: Phase 2 (interviews 6-18, documents, observation)

**Code Name/Label, Definition, Example** (DeCuir-Gunby, 2011)

Many codes encompass both positive and negative aspects, or both the presence and the lack of the concept or attribute.

Knowledge = educational pedagogy; awareness of technology capabilities; understanding of the links between the two (Militello & Ersozlu, 2013)

- **assessment** = capacity to evaluate testing results in order to make decisions; e.g. item analysis "You're assessing on the bad device that you've devised yourselves, or pulled up from some test vendor. Then you point ... you mis-attribute the problem."

- **awareness of technology** = recognition of available technology, or technology that would solve expressed data needs "In your opinion, is Schoolnet going to provide some of what you need?" "In my opinion, I don't use it enough to even give you an opinion."

- **seasoned vs. novice** = principal knowledge "More seasoned administrators can't get it. They have to wait for somebody to put it in their hands. Then when they get it, they know where to go. I know to spend this amount of money in October. I know to hold money for January ... I know to spend my April - June money on this date ... They know the series of how to be successful. They don't know how to get, what to use to get to it. They've been super-dependent on the district to do it. Somewhere you got to marry that. You've got to be a getter and someone who knows what to do. I don't think it exists right now."

Skills = finding meaning in data, manipulating spreadsheets, budgeting, managing district and state resources

- **interpretive assistance** = a tool or an additional person's services that help make meaning of the data " Even when we start looking at reports, for district benchmarks, I go ahead and I print the reports for them. I give them a copy of it and then together we sit down and look at what the report says, what does that mean, what does that mean for my instruction? What kids should I pull to remediate? What standard do I need to remediate?"

- **principal as data analyst** = does the principal interact / engage with data and make meaning "I will provide reports to the principals. I don't think there are many administrators in our district that use Schoolnet. They usually depend on their curriculum people to get the data from Schoolnet and provide them with the information."

- **principal as data coach** = examples of the principal leading other staff in data-based decision making "To me, as a teacher, you have to look ... you can't just keep ... "here's the material, we're going to test you". And you've got Johnny who made a 48, then he made a 52, then a 48. He's going to keep doing that if you don't look back and see why. What is he not getting?"

- **spreadsheets: skills / lack** = expressed comfort with Excel, manipulating data (sorting, filtering, making tables) AND the access to spreadsheets if desired "sometimes when you're maneuvering around, you can come across some things where you're like, oh, it's
not as bad as I anticipated. Or, oh, god, it's worse than I thought it was. But you have to be able to move those things around and look at it individually like that."

**Non-Principal Experience:**
- **business** = experience with corporate culture, business trainings like Six Sigma; also references to the differences between the corporate world and education "the financial pay scales and things like that - In industry there's more external incentive to move up the ladder from the perspective of performance. In education it's a very intrinsic motivator that keeps you learning and driving forward, wanting to do better."
- **math** = former math teacher; references to being (or not being) a "math person" or a "numbers person" "Little bit of everything but math. That's about the only thing that I have not taught."

Dispositions = attitude or mood; tendency to act or think in a certain way (http://www.merriam-webster.com)
- **curious**= eager to know or learn something "Each time I get data, thinking, what have I not looked at? How deep do I need to go this time to give me a little more information than I had last time?"
- **living in the data; situational awareness**= connected to / engaged with the data; includes being connected to the school in terms of other data (observing, hearing, talking with stakeholders) and situational awareness (Marzano, Few) "Now someone is preparing that spreadsheet for me. Then I'll get it, and I'll look at it, but you're lost in the ... You don't own it. That lets me know how much that piece of owning that would then lend itself to ... the teachers."
- **motivation**= shows impetus to collect data, refer to data, use data for decision making "We would literally ... as soon as the scores came in ... She'd read it and I'd type it in. We'd quickly come up with it. We weren't waiting like two months later for the state to tell us, or ... the spreadsheet would be built and as soon as she'd get the data, we'd enter it in."
- **organized / detail-oriented**= thinks in terms of a system / a systemic process; considers being organized a necessary quality; comfortable with the details of the solution "Then major, which is office-managed. Now, teacher-managed, which is minor, can become major if it's repeated over and over. Then we have a step process. Basically, it starts out with a student conference and warning that's documented."
- **persistent**= continuing firmly or obstinately in a course of action in spite of difficulty or opposition. "I wanted to get that deep into it to see, ok, by classroom and by grade level, which passage ... Come to find out, it was our technical passages that had step-by-step how to do something."
- **problem-solver**= mindset of looking for solutions; focus on problems that can be solved "If all you do is drop numbers all the time, then you start sounding pretty accusatory. It's better to talk to people about how they feel like things went. Here's what the data says, but this isn't the end-all, be-all. But what do you think? Is this accurate? If not, why do you think it's inaccurate? Where do you think it came from? What can we do about that?"
If it's our own data, how can we correct that? Do we need to change the question? Do we need to do something different? If it's state data, then we have to talk about what we can change. What's in our control?

- **talk to people**: informal surveys, or references to situational awareness that results from talking to stakeholders. "I think that's another one of those things that you can fall into when you have too much tunnel vision when you're looking at data; you quit talking to people."

- **time / willingness**: expresses the time available or lack of time; demonstrates a willingness or lack thereof for data use. "I just don't have time ... to do that. To be honest, I wait. Until I get it in a spreadsheet that I can manipulate into charts and pivot tables ... I just don't have time to go through all those PDFs and come up with the information I need. I just don't do it, I wait."

- **trust or mistrust of data**: confidence in data; note that mistrust of data can have a positive effect. "Once an administrator can learn do some of this reporting ... once they can learn about some of the reporting, then they won't be so quick just to take that benchmark data that say, the district runs for you, and take that as the gospel."

### Additional roles = developing / using other staff as the school's data scientist: district support staff, curriculum specialists, assistant principals, instructional facilitators

- **district staff**: examples of central office staff providing access to data or interpretive assistance. "We mine public data sources in order to do comparisons of data across districts and across schools. That you won't see in other districts at all. We create basically a virtual comparison loop by matching against other districts: poverty rates, their size, and their demographics in order to say, here are districts in the state like ours, and then we compare their state assessment results to our state assessment results in order to give the schools comparisons. Are you doing the same or better on the students that have the same general characteristics. If the other school is doing better, go find out why. That's something the principal is able to assimilate. Ok, here's 8 people that are doing better than you are. Go look at what they're doing."

- **other school staff**: examples of curriculum specialists / instructional facilitators / assistant principals playing a key role in data access / analysis / decision-making. "In this system, I think the bulk of the data resides in the curriculum position."

- **HB: interface or dashboard**: references the consideration of HB as a single sign-on or a dashboard (coherent, integral to strategy). "I always go to it with, "I need this information". I really don't pay that much attention to the dashboard because the dashboard takes into consideration all the assessments we've done, all year." (Schoolnet user)

- **HB: products: pros and cons**: discussion of the HB suite of products in particular (Schoolnet mostly); includes general technology references (connectivity, access to computers). "Or, when we had benchmarks throughout the district, when there were a lot of students accessing at the same time, it would knock students off, or they would have a hard time. Those would be the downsides, the concerns."

- **HB: whole or parts?**: branding issue and how HB is viewed: individual products or a coherent whole system; in WCPSS interview, the sense that there is no dashboard. "For me to have a good awareness of what's going on in my building and how are my students
performing... I don't have a tool to do that right now, so I'm isolated from what's really going on"

- **training**= professional or educational experiences they've had in or outside education that were influential; references to training they've not had. "I've never had a class on disaggregating data. Even in grad school, we didn't dig into it that much, how to use data, what it means, that kind of stuff."

- **training / support they need**= references to training or development or support they think would make a difference. "I think working with ... I mean if you pair someone who is good at digging deep in that data and can sit down with others ..."

- **leapfrog effect**= evidence that smaller or more rural school systems are more likely to advantage of state-provided technology, which may give them a leg up on the potential of dashboards. "She worked at DPI before she came here. She was on that planning committee, when Schoolnet came about. When she came here, she said, we're definitely buying it. This is not going to be an option for us. We have bigger systems close by who haven't even touched it."

- **implementation variety**= differences in hardware or connectivity; differences in extent of commitment to HB. "Then our district got the Impact grant. That enabled us to do a one-to-one initiative with our middle and high schools. All of those student have these little MacBooks. This past year we tried to do some online testing with Schoolnet and it worked out great."

- **reports**= either static summaries of information; or with HB, exporting for analysis  
  ○ Choose and run a report  
  ○ Create a PDF of your report  
  ○ Export to Excel

- **rights and permissions**= the impact of establishing permission (via the technology) to certain information so that users can see what they need to without infringing on the privacy rights of students. "In NCWise, you could click on the kid and look at their transcript and look at all of their data. With PowerSchool you can, if you contact your data manager to get all that information. It's not that it's not doable, but you don't want to give all your teachers counselor rights. That's how it's done in the PowerSchool system."

- **benchmarks or KPIs**= references to benchmark / formative / summative assessments as well as references to standards, or a need common standards. "you have to determine what says that this is a successful school. Once you know what those things are, you determine what fits in that category."

- **data to depersonalize**= taking away the stigma associated with data; using data in a nonthreatening way. "Where are you getting this from, what does this mean? So, just to try to remove some of those barriers, so it's not just me as a teacher feeling attacked by administrators, but knowing, all year long, where my students are."

- **data to personalize**= associated with drill-down capacity; using information to individualize, to target specific student(s). "We drilled it down to the actual classroom and then we drilled it even further to look at the students, different groups of students."
Other

- **access is an obstacle** = technology issues or lack of technology block use of data "At the time, Power School didn't provide that sort of functionality. Maybe it will. Some of the things that, we came into conflict with the Exceed model was it was still like you could look at your data, and I could look at my data, and we could look at the third person on my team's data but we couldn't put all of our data together and look at it."

- **analytical thinking** = not a knee-jerk reaction to data (up is good, down is bad); references to analysis of data's meaning "G to I. That's only two levels, but people were feeling good. Oh, they grew two levels. But then when you look at it, technically they should be growing four levels a year. And this is a child that has had, apparently, double dose all year long. That child should be making six levels of growth."

- **children, story behind the numbers** = discussion of the importance of seeing a student instead of a number, or understanding the situation behind the data; understanding "what populates" the data "There's so many places you get the data from. It's not all about test scores. You're dealing with people."

- **decision tree; help with decisions** = technology-provided decision-making help; can go as far as "absolutes" (if a, then y) "a decision matrix to go along with the presentation of the data"

- **decisions and data: relationship** = the early stage of data-based decision making; how data and decision making first come together (prior to the process of taking action) "...Kendra's report grades really don't line up with quarterly district assessments. Is there a mismatch here? Does this teacher need some professional development? In my opinion, you're able to look at this as an administrator and pinpoint professional development needs. You want to do an in house coaching model. ...To me, there was so much more you can do with the data than just say, oh, that kid failed."

- **external to internal** = references to external demands (from the state or district) which have influenced decision making at the school "I know that our district will be fully using Edclick, which is something that we can access through Home Base. I know that we'll be using that to help with monitoring of discipline. But also, because of that, we are also looking into having a PBIS team."

- **fear; trust or mistrust of data** = fear of data or dealing with data; references to data being trustworthy or not "fear of the data, as a meaningful piece of information without making it a summative judgment about somebody's ability."

- **hates paper, wants to automate** = use of Google tools, references to going paperless "I've already introduced a lot of Google Doc stuff. I've thrown a lot of technology on them."

- **PLC / data teams / SIT** = discussion of PLCs or data teams; references to School Improvement Plans or Teams "If you have someone there to help facilitate that conversation, it can be very powerful and impact instruction."

- **taking action** = planning, executing, monitoring action (taking action based on data) "the more we got into documenting things we realized that someone could say, like, oh, yes, I'm providing this intervention. Yeah, but, what does that really look like? The big thing was a double dose of guided reading. Oh, like, Kendra is not progressing. Come to find out, well, she didn't really have a double dose of guided reading."