DATA DASHBOARD IMPLEMENTATION
A REVIEW OF THE RESEARCH LITERATURE

Maia Young
James Lamar Foster
Charles Peck

WINTER 2020 | UNIVERSITY OF WASHINGTON

Supported by the Bill & Melinda Gates Foundation
Data Dashboard Implementation:  
A Review of the Literature

Maia Young  
University of Washington

James Lamar Foster  
University of Washington

Charles Peck  
University of Washington

This report was prepared for the Bill & Melinda Gates Foundation. The findings and conclusions contained within are those of the authors and do not necessarily reflect positions or policies of the Bill & Melinda Gates Foundation.
Executive Summary

The rapid development of new information systems and related data management tools is one of the most dramatic features of organizational life in the early 21st century. However, focusing on the creation of new information technologies can easily lead policy makers, funders, and organizational leaders to overlook the challenges of implementing these tools in complex ecologies of institutional policy and practice. In this document, we summarize what we have learned from a review of 141 studies related to the implementation of new information technologies. We focus in particular on challenges that accompany the introduction and use of “data dashboards” (DDBs) in the fields of business, health sciences, and education. We offer suggestions for academic leaders, technical assistance providers, and policy makers currently working to make data dashboards and related information technologies useful and used as tools for program improvement in teacher education.

What We Learned

Notably, across all of the studies that we reviewed, we found that organization leaders, funders, and policy makers almost always underestimate the complexity, time, and cost of developing and implementing data dashboards. System designers, users, and leaders typically focus their time, attention, and resources primarily—and too often exclusively—on technical issues related to tool development, with relatively little strategic attention to the social and organizational change processes necessary to support tool implementation. This often leads to surprise, frustration, and both cost and time
overruns with implementation, and ultimately, failure to deliver on the promise of new information technologies as tools for program improvement. Based on our review, we suggest three strategic actions organizations may undertake in order to increase the likelihood that investments in data dashboard development and implementation lead to meaningful use of these tools for program improvement:

1) **Develop a careful and strategic plan for dashboard development and implementation**, including an integrated analysis of user goals, values and skills, an analysis of local organizational work processes into which the data dashboard must be integrated, and an analysis of the long-term costs of maintaining and modifying dashboards in response to evolving user needs.

2) **Appoint and support a special multidisciplinary implementation management team** with members representing both vertical and horizontal dimensions of the organization(s), and charge this team with monitoring, evaluating, and coordinating the dashboard development and implementation process.

3) **Conduct an ongoing study of the implementation process**, using interview, survey and focus group data to create a feedback loop to inform implementation planning and support decisions.

Each of these recommendations, and the research on which they are based, are discussed in more detail in the main body of our report.
Organization of the Document

Our objective in this review was to locate, analyze, and report research which might be useful for organizational leaders who are working to implement data dashboards as tools to improve teacher education programs. Consequently, the report is organized with busy leaders in mind. We lead with a summary of our findings and recommendations. Supporting material is appended for those who have the time, interest, or need to make a deeper dive into the research literature itself. The lens through which we appraised the research was based on our practical work experience in teacher education and educational leadership. We do not claim scholarly credentials in the areas of implementation science, organizational change management, or socio-technical theory. We have filtered these enormous and rapidly expanding research literatures by asking ourselves “might this be useful?” for our teacher education colleagues, and, more broadly speaking, for policy makers, philanthropic organizations, and technical assistance providers who work to make emerging information technologies more useful and more regularly used for program improvement in teacher education.

Contents

I. Introduction and scope of the project
II. Summary of Findings
III. Discussion and Recommendation
IV. Appendices
   A. Method
   B. Findings
   C. Further Reading
   D. Comprehensive list and access information for studies included in the review
V. References
Introduction

Perhaps the most common contemporary theory of action related to program improvement in teacher education is the notion that programs can be improved through the systematic collection, analysis and use of data to identify efficacious program policies and practices, followed by systematic implementation and evaluation of those policies and practices over time. This idea is evident in national and state-level accountability policies, as well as professional accreditation standards. It is also the focus of substantial investment in new data-related information technologies by government agencies, commercial vendors, and philanthropic foundations.

Of course, the idea that emerging information technologies can accelerate and improve data-based decision making is not new. The development of new technological tools to support the collection, aggregation, and analysis of data as a resource for organizational improvement has been vigorously pursued in other fields, and a substantial research literature has emerged from this effort, particularly in the business and health science sectors. This literature describes the challenges organizations have encountered in developing and implementing new information technologies aimed at program improvement. In this document we review these studies, focusing on empirical research on implementation of new information technologies in business, health sciences, and education. The research in each of these fields is highly diverse in both theory and method, making findings difficult for aggregation and direct comparison. Consequently, our goal has been less to summarize and evaluate the current status of knowledge and practice in these fields, but more to identify themes and examples from each field and present them in ways that we believe may be useful for anticipating and engaging challenges of information technology implementation in teacher education.
The particular focus of our review has been the development and implementation of “data dashboards” (DDBs), as these technologies are currently being developed and/or adopted widely to monitor, evaluate and improve programs of teacher preparation. However, our initial reading of the relevant literatures made it clear that many of the implementation challenges for new information technology tools are similar whether the tool in question is a data dashboard, or a larger information technology such as a Learning Management System (LMS), Health Information Technology (HIT), or an Enterprise Resource Planning (ERP) system. In our review we tried to gather and synthesize recurring findings from all of these kinds of studies, with specific attention to those we thought to be of potential value to teacher educators. Notably, teacher education—and education in general—is far behind other fields in knowledge and use of information technologies to guide programmatic decisions (Norris & Baer, 2013). And, while we acknowledge that the mission, history, and institutional context of teacher education programs are quite different than those of business and health science organizations, our review suggests there is indeed much teacher educators can learn from those fields.

There are a variety of perspectives and concerns about data-centric approaches to program improvement, including choices of program outcome measures and appropriate locus of authority and agency related to data and decision making (Cochran-Smith et al., 2018). We take these concerns seriously. There is, however, little reason to expect that the rising tide of interest and commitment to the uses of data for decision making in teacher education will recede. The challenge is to learn how
to use the rapidly expanding array of information technology tools not simply for accountability
reports, but as a resource for learning and program improvement.

**Conceptual Framework**

We approached the task of organizing, analyzing, and interpreting the extensive and diverse bodies of literature related to DDB implementation in the three work sectors (business, health sciences, education) using theoretical assumptions drawn from socio-cultural theory in general, and from Cultural Historical Activity Theory (CHAT) in particular (Engeström, 2001; Gay & Hembroke, 2004). CHAT has well-established value in analysis of the relationships between technology, learning, and organizational change (Kaptelin & Nardi &, 2006). One broad assumption we made based on this general theoretical orientation is that specific technical tools, like DDBs, make some things more visible, while occluding others. We further assumed that the social organization of work processes—that is, the ways in which work gets done in organizations such as teacher education programs—affects and is affected by the nature of the tools used to undertake that work. Whether a tool, like a DDB, is *useful* depends not only on the features of the tool itself, but on the features of the work setting. Finally, we assumed that the values, beliefs, and skills of the people involved in a specific work setting affect how they use—or decline to use—specific information technologies.

We used the People-Tools-Organizations (PTO) framework, developed by McDiarmid & Peck (McDiarmid & Peck, 2012; Peck & Davis, 2019), as a conceptual framework for organizing our review. This meant that as we read each study we paid particular attention to the characteristics of the people involved in the technology implementation effort, the affordances and constraints of the
tools under study, and the organizational policies and practices of the work setting to understand how each parameter individually and jointly affected the implementation process.

We conceptualized the people-tools-organizations dimensions of each work setting as a set of relatively static conditions affecting implementation—we thought of these as “structural” elements of the work setting. In addition, we also conceptualized “process” variables as those constituted by a series of events characterized by dynamic change. Examples of processes that were identified as important in the studies we reviewed included leadership, training, and implementation planning. While we found the “structure/process” distinction to be helpful to our efforts to identify themes in policy and practice that might be useful for teacher educators, we were also well aware that these distinctions are somewhat arbitrary and subject to conceptual debate. Figure 1. depicts the analytic model as we used it to describe questions we had about how structural and processual features of a work setting impacted how new information technologies were implemented.

Figure 1. People, Tools, Organizations, and Processes
Summary of Key Findings

In reviewing the existing literature through the lens of the people, tools, and organizations framework, we identified several cross-domain commonalities that provide insight into the implementation of data dashboards. We have focused our analysis here on findings most pertinent for teacher education programs hoping to utilize DDBs in their program improvement work.

People: The Importance of Users and How They View the Dashboard

Across all three domains, researchers described the importance of individual users’ beliefs and perceptions, skills, and stances with respect to the implementation of data dashboards and related information technologies. For example, in business and health literatures, we found evidence that while users’ beliefs about whether the dashboard was a useful and usable tool affected their use of the dashboard, these attitudes and beliefs were not static and could be shifted (Amoako-Gyampah, 2007; Sligo et al., 2017). In the education literature, researchers also observed that users had strong beliefs about the value of data dashboards, particularly in terms of their purpose. For instance, in their research in three school districts, Cho & Wayman (2014) reported that users’ views about the value of data varied across districts based on whether districts used data for improvement of instruction or for accountability measures. Teachers were more likely to view data as useful to the extent that they saw it as a lever for improvement, while administrators saw data
primarily in terms of its utility for external reporting and accountability. This suggests that perceptions of data use may vary by role (Cho & Wayman, 2014).

User skill was an important factor in implementation across all three domains (Greenhalgh et al., 2008; McCoy & Shih, 2016; Rajan & Baral, 2015). Greenhalgh et al. (2008) juxtaposed two medical practices which were adopting a new technological tool. In the first practice there was a high level of in-house expertise, whereas in the second practice technical expertise was not seen as a key skill needed by all staff. The second practice experienced delays in implementation and had to rely heavily on external support, whereas the first practice had a relatively smooth implementation and were able to utilize in-house expertise to provide needed support. The authors assert that implementation may go more smoothly if there is pre-existing technical knowledge and/or if staff training is prioritized.

In addition, we found that while user “resistance” is often cited as a barrier to implementation, the reasons for this resistance were varied and carried different implications for action (Abraham & Junglas, 2011; Haddara & Moen, 2017). Sometimes users resisted when they felt that their views or needs had not been considered in the design or implementation of a dashboard (Haddara & Moen, 2017). However, user resistance may also emerge from fear that the dashboard would fundamentally change their work or cause a loss of professional autonomy. For example, physicians worried that implementing health information technology would shift the focus of patient care away from the doctor patient relationship and toward the collection of data (Cresswell & Sheikh, 2013).
Tools: Features Related to Access and Usability

DDB features impacted how users responded to implementation. For example, Furmankiewicz et al. (2015) found that dashboards that were visual, uncluttered, and interactive were more likely to be incorporated into practice. Similarly, Sligo et al. (2017) observed that dashboards “should be intuitive, easily customised, have quality interface design and require little training” (p. 92). This suggested that designing DDBs for ease of use can also ease later training demands.

Designing the tool went beyond the physical layout of the information. For instance, our review suggested that the selection of DDB measures that aligned with specific program improvement goals or problems of practice were likely to produce more user engagement (Kawamoto & Mathers, 2007). This is the case in Swan’s (2009) study of dashboard implementation in a teacher education program, which began with the observation that rich artifacts of teacher candidate practice were routinely collected in electronic portfolios but not used in ways that seemed to afford opportunities for teacher educator learning and program improvement. A data dashboard was developed and measures were designed to address this particular problem of practice, and the tool was then used by faculty to identify issues of concern at both the level of individual candidates and for the program. As noted previously, whether or not measures were useful to the practices of users depended on the role the users had within the organization. As noted by Cho and Wayman (2014), teachers will have different needs than administrators, and these needs will determine what measures are useful for each group.
While attention to local needs was clearly important, one of the ongoing tensions described in the literature had to do with how to balance the need for local customization of a dashboard with the need to have a dashboard that was interoperable with other systems. A customizable dashboard would be more responsive to local needs and contexts (Cresswell et al., 2012; Swan, 2009). However, the more customized the dashboard became, the less able it was to work with other data systems.

Boonstra and Broekhuis (2010) cited one survey in which researchers found that there were 264 unique types of electronic medical records software being used by providers. This lack of standardization across institutions and data systems made it challenging to map the status of health data across organizations.

Organizations: Context, Collaboration, and Cost

Organizational conditions profoundly affect the implementation of data dashboards. We found that dashboards may be a useful tool in supporting a culture of data use for decision making and program improvement, but only if organizational conditions are in place to support collaboration. For example, Davis and Peck (In press) found that the actual use of data for program decision making was dependent on allocation of substantive time and opportunity for interpreting the meanings of the data presented, and deliberation of their implications for action. It should also be noted that if access to information is restricted or otherwise inaccessible to users based on their role, dashboards have the potential to exacerbate problems of collaboration and communication rather than reduce them (Gummer, 2019; Lluch, 2011).
We found evidence in both the health and education literatures that organizational structures that created silos of practice caused particular problems for collaborative work, including the kinds of collaboration required for data dashboard implementation. For instance, in implementing an information system in a networked healthcare setting, Abraham and Junglas (2011) found that conversations between physicians, nurses, technicians, and administrators were challenging because of how little practitioners understood about one another’s roles in the process of patient care. Similar patterns were found in university settings where administrative structures are highly decentralized, with academic departments and colleges operating largely independently from one another and from central administration (Bologa et al., 2009). These silos of practice can impede joint use of a tool such as a DDB.

Another important organizational consideration is the way that current work processes interact with a new DDB. This was particularly clear in the medical literature. Gagnon et al. (2012) observed that unsuccessful implementation was frequently linked to a mismatch between the tool and existing work practices. In their review of the literature, Boonstra and Broekhuis (2010) described one study where 92% of physicians felt that having to interact with a computer during a care encounter interfered with their ability to communicate with patients in the moment. The authors cited a second study in which physicians described how the process of “hunting for menus and buttons” within the health information system interfered with their work, which led to abandonment of the tool (Boonstra & Broekhuis, 2010, p. 11). Stone and Yoder (2012) recommended designing or choosing information technology tools “that emulate[s] existing
workflow when possible” because research showed that the closer the use of the tool was to existing practice, the more likely users were to use it (p. 210).

Issues of context, collaboration, and customization have important implications for the cost of an implementation project. For instance, contextual factors such as large organizational size might afford additional resources, which could ease implementation and enable ongoing support (Cresswell & Sheikh, 2013). However, larger organizations may take more time to select and implement a system (Boonstra & Broekhuis, 2010), which could cause costly delays and loss of momentum. We found that organizations primarily conceptualized DDB implementation only as a technical project and, therefore, routinely underestimated the resources needed to carry out the work. Resources needed for implementation went beyond the initial cost of purchasing or adapting a system. Organizations also needed to pay for ongoing support and upgrades to existing infrastructure. Cresswell and Sheikh (2013) suggested that leaders could facilitate implementation by decreasing individual workloads and timing implementation activities to take place during a period in which no other major organizational upheavals were occurring.

**Implementation Processes: How the Work is Done**

Our review of the literature suggested that organizations that attended to the multiple intertwining factors affecting dashboard use—including user needs, existing work processes, and organizational culture—had more success in implementation efforts (Abraham & Junglas, 2011; Ahn et al., 2019). However, as noted above, we found that it was far more common for implementors to focus almost exclusively on technical aspects of implementation. For example, Macfadyen and Dawson (2012)
studied the implementation of a learning management system in a large research-intensive university. They found that discussion of using the system for instructional and program decision making was almost entirely absent and commented, “while there is an obvious imperative to ensure that any new enterprise technology is functional, scalable and reliable, an exclusive focus on technology integration issues, in the absence of development of a pedagogical vision, quickly neutralizes the likelihood that learning analytics data may catalyze organizational change” (p. 159). They assert that attention to public and collaborative negotiation of the purpose of the dashboard is integral to the clarifying the use-value of the tool, and its relevance to shared agendas for program improvement.

In addition to collaborative negotiation of shared purpose, several studies identified the importance of engaging users in the process of designing, developing and implementing a data dashboard so that it is as well aligned with existing work processes as possible. For instance, Abraham and Junglas (2011) described how Sentara, a networked health organization, formed two coalitions of stakeholders, including future users, to plan and implement a new health information system. Berg (2001) asserted that user engagement should go beyond participation in meetings to discuss system specifications and fit. He recommended that those implementing a new technological tool use “ethnographic methods, studying the detailed social organization of actual working practices through participant observation methods and in-depth interviews” (Berg, 2001, p. 148). Other studies used exploratory action-feedback approaches (Jeskey et al., 2011) or blends of pre-existing assessment tools for understanding organizational needs, coupled with user and stakeholder interviews to guide planning and implementation (Panayiotou et al., 2015).
User training was another important process that emerged from our review of the literature. We found evidence that training was more effective when it involved users actually working with the new tool as opposed to simply having information presented (Schifter et al., 2014), and that training that included ongoing user support was likely to increase user acceptance (Keshavjee et al., 2006, cited in Cresswell & Sheikh, 2013). Davidson and Chiasson (2005) outlined one way that organizations could support use-based ongoing support in training. They described a case where a health organization handled the installation of a new system by paying and reassigning physicians, nurses, pharmacists, and other clinicians with pre-existing technical skills to the work of installing the system and training other users. After the system was installed and new users were trained, “these groups transformed into permanent organizational resources” to support users and keep the system updated (Davidson & Chiasson, 2005, p. 11).

Leadership was almost universally acknowledged in the literature as crucial to successful dashboard implementation, whether situated in health, business or education settings. Both centralized and distributed leadership were widely viewed to be important to dashboard implementation (Ludwick & Doucette, 2009). Distributed leadership practices appear to be especially important in higher education settings, where faculty participation in “shared governance” is protected by both historical norms and university policy (Macfadyen & Dawson, 2012). In her study of “high data use” teacher education programs Davis (2019, in review) identified a variety of “bridging practices” university leaders used to transform the individualistic faculty culture prevalent in most institutions toward a more collective orientation to learning processes related to data use.
and program improvement. These practices included reframing program narratives to emphasize collective aspirations for program improvement via data use, creating organizational policies that aligned individual and collective goals (e.g., creating an internal small grants program support program-focused research), and aligning data use work with local faculty and staff values. While these leadership practices were centralized at times, leadership was also shared with program faculty and staff, who felt a strengthened sense of “collective self-efficacy” that helped them feel better able to respond to external accountability pressures in ways that did not abandon local values.

**Connecting People, Tools, Organizations, and Processes**

We found that data dashboard implementation was affected, not only by each of the individual model parameters (that is, people, tools and organizational contexts), but also by the interactions between them, as well as the processes employed to support the implementation process. Figure 2 depicts some of these relationships. In this section we draw on two examples from the literature to show how dashboard implementation may be affected by the interactions between the characteristics of the people, tools, and organizations in specific settings. We then consider leadership, collaboration, and training processes and how these may affect the relationships between people, tools, and organizations.
The relationship between user values and needs, features of the dashboard, and organizational work practices. Ahn et al. (2019) employed what they called “traditional ‘in-the-lab’ user testing techniques” to develop a data dashboard for classroom teachers to be used in mathematics instruction. Early in the design process, developers followed recommendations from the design literature to “direct the user’s attention to salient aspects of a data visualization” (p. 76). Developers assumed that the data which would be most salient to teachers would be about how many students produced correct answers to math problems. However, as they tried to implement the dashboard, the researchers discovered that foregrounding data on correct answers interfered with teachers’ actual work practices, which emphasized analysis of their students’ errors in ways that helped them improve instruction. Thus, dashboard data foregrounding correct answers weren’t that helpful. Even more problematic, when a “right answer” became the focus of the dashboard, teachers reported that they began shifting their work practice toward getting students to make the right answer choice, rather than trying to understand student misconceptions in ways that might support...
their learning. Ahn et al. (2019) also reported that, for some teachers, the focus on right answers positioned the dashboard as an artifact of external accountability interests, lending a feeling that teachers were “being watched” (p. 77). As the researchers developed a more holistic and contextually nuanced understanding of the relationships between the goals of the teachers, the teachers’ work practices and routines, and the features of the dashboard tool, they were able to make changes to the dashboard that made it more useful, and more readily used as a resource for instructional improvement.

Relationships between users, tools, and organizational conditions in a higher education setting. Research reported by Pollock & Cornford (2004) demonstrates how similar interactions between the characteristics of people, tools, and organizational practices also shape the implementation of new information technologies at a broader organization level. Studying a large research-intensive university in the UK, the researchers described the implementation of a comprehensive Enterprise Resource Planning (ERP) information system over a period of three years. In this case, the researchers commented on how the structural features of the university, including decentralized decision authority distributed across small, semi-autonomous university departments, intensified the challenges leaders faced in understanding and managing the volume and diversity of implementation problems:

The committee overseeing the system roll-out (made up of a number of vice chancellors, the registrar, bursar, various deans, and senior administrators) met once a week intending to resolve these demands but, as described by the project administrator: “the Committee were getting 20 issues a week to resolve and therefore usually did not get past the first or second one on the agenda” (p. 41).

The difficulties that leaders encountered in managing the number and diversity of implementation challenges meant that many of the conflicts between the features of the new information technology
and existing work routines and practices went unresolved... which in turn resulted in staff managing those conflicts by developing local “work arounds.” The added work involved, in turn, exacerbated faculty and staff concerns about the value of the ERP system. One department leader described these interwoven challenges in this way:

Now when [Enterprise] comes in, the academics are going to have to conform to quite a lot of rules and regulations that they don’t now. How on earth I am going to get my lot to do it, I do not know. Whether the centre has realised this, and is just not telling us what they are going to do about it, whether they are just going to trust to luck and hope that it works I just don’t know. But, I am quite concerned about that. I mean it does create bad feeling if you are saying to somebody: “Look you just can’t just make an order off the phone; I won’t pay for it if you do. it must come through the office, that’s the system”... And I can see that they are going to start screaming, as soon as I say to them: “Sorry, you can’t do that anymore you have got to do that now, that’s what the system is supposed to do” (p. 43).

Again, the challenges of the implementation process were constituted, not simply by the motivations of the people involved, by the features of the information system itself, or the organizational features of the university...but by the way all of these interacted with one another.

Of course, these conditions themselves are not static, but are shaped and re-shaped by how the work of implementation is carried out. We found evidence across studies in business, medicine and education that suggested how the quality of leadership, collaboration, and training processes all affect implementation outcomes. For example, Abraham & Junglas (2011) described how the CIO of a large healthcare organization created coalitions of stakeholders to assess and respond to the challenges of implementing new information technology. A particularly important leadership strategy involved supporting collaborations both horizontally, across units and organizations, and also vertically, integrating front line practitioners with those in leadership positions. Each of these
collaborative configurations was essential to developing and carrying out a comprehensive implementation plan, including ongoing analysis and management of the interplay between personal, technological, and organizational aspects of the implementation process.

Sloan (2013) described similar leadership and collaboration processes in a teacher education program, wherein the director and leadership team worked to create new roles and responsibilities that both recognized existing leadership skills among faculty and staff, and opened up new opportunities for cross-unit and cross-role collaboration within the organization. Like the Abraham and Junglas (2011) report, Sloan reported that the collaborative processes developed to implement new information tools also created important opportunities for practitioners to learn more about their roles, and the roles of their colleagues, in their collective work process. Taken together, these process-oriented studies show how, by creating opportunities and supports for distributed leadership and collaboration among faculty and staff, organizational leaders can engage local expertise as a resource for innovation and creativity in managing the challenges of dashboard implementation in their own settings.

**Promising Practices and Recommendations**

In addition to the themes we found in the literature regarding the dimensions of people, tools, organizations, and processes, the larger overarching message we took away is that local context matter when it comes to implementation. We came to view the challenges of data dashboard implementation as a classic example of what Rittel and Weber (1973) have conceptualized as “wicked problems.” Wicked problems are protean — they change, even fight back, as you work to solve them. Each problem must be understood in real time and in local context because each instance of a wicked problem is inherently unique and dynamic involving the specifics of local history, institutional context, and people involved in the work. Research on wicked problems related
to adoption and implementation of new information technologies suggests that a 'satisficing' or 'good enough' solution may be the realistic goal (Fitzpatrick, 2003). Our review of the research literature suggests that all of these “wicked” qualities attend the process of developing and implementing a data dashboard, and that it is important to know this before undertaking the work.

In this section, we draw connections through the specific studies and related literatures to suggest some “promising practices” that we believe worthy of general consideration in planning and supporting data dashboard implementation. In doing so, we are reminded that one of the most important precepts about “wicked problems” is that no two are exactly alike. Our recommendations are thus offered with deference to local judgment about how they may or may not fit into local context and circumstance.

**Recommendation 1: Carry out a careful and strategic assessment of local conditions likely to affect DDB implementation.**

Data dashboard initiatives often originate in the heat of excitement about the prospective affordances of a new tool, or perhaps even more problematic, from the availability of new resources and/or requests for proposals from outside funders. One of the most serious risks at this stage of implementation is that the complexity and scope of the implementation challenge will be underestimated. We offer a list of questions below that may be useful in planning implementation strategies and supports responsive to local needs:

1) To what extent are decisions about dashboard use within your organization centralized, or distributed across multiple organizational units?

2) How do end users within your organization perceive the purpose and potential value of the dashboard? How do these perceptions vary across users and organizational units?
3) To what extent is the dashboard initiative supported by key administrators/leaders within your organization, and how is support from these leaders likely to affect implementation?

4) To what extent does your organization have established within and cross-unit communication policies, structures and routines as needed to manage the implementation process?

5) To what extent are general data use policies, routines and practices well established in your organization/program, and how will the DDB be integrated into those routines?

6) What resources will be needed to manage and support, not only the technical development of the dashboard, but also the organizational change processes required to implement the tool and sustain its use over time?

**Recommendation 2: Establish a multidisciplinary implementation management team representing both vertical and horizontal dimensions of the organization.**

One of the most important things we learned from the dashboard implementation literature was that the implementation of a data dashboard is likely to affect, and be affected by, the work practice of people situated across organizational units, and across organizations. *Our review suggests that understanding and managing these connections is crucial to the implementation process.* While it may be tempting to assign the management of dashboard implementation to an existing work group, this “add-on” approach risks burying the dashboard initiative in competing agendas and broader conversations that do not allow the focused deliberation and problem solving that are required to successfully implement new information technologies so that they are useful and used for program improvement. Members of an interdisciplinary team might include academic leaders from central administration as well as the units expected to use the dashboard, IT specialists from the units involved, end-users including faculty, field supervisors and unit staff, and representatives of
collaborating organizations. The management team may not always function as a committee of the whole, but it is essential that clear structures and processes for communication be developed. A joint planning and accountability tool (e.g., a RACI chart: Responsibility assignment matrix) may assist the team in development of a shared understanding of personal and organizational roles, responsibilities and timelines as well as providing a common language to support communication and collaboration across organizational boundaries (Fitzpatrick, 2003).

**Recommendation 3: Conduct a “self-study,” in which data are collected on the dashboard implementation process as it proceeds. Use these data as a resource for planning and decision making.**

Our review of the literature alerts us to the fact that the challenges of dashboard implementation should be expected to unfold in a unique and dynamic way in each organizational setting. Monitoring, understanding and managing the implementation process can be greatly aided by continuously collecting a ground-level account of what is happening with the project from the people involved in the work. This means conducting intermittent interviews, focus groups, or surveys that provide timely information and feedback from participants. These are likely to reveal important differences in how organization members view the purpose and process of dashboard implementation. It is important that these process data be collected with some degree of anonymity to ensure that participants may safely express views and concerns that may be unwelcome to organization leaders. When anonymity is protected, self-study data can offer useful feedback and guidance for the implementation process as it proceeds.

In Appendices A through D we describe the method and findings of our review in more detail.
Appendix A. Method

Our goals for the literature review project emerged from our experiences with a very specific problem of practice: how can a teacher preparation program implement a new technology (such as a data dashboard) in ways that make it both useful and used? Our experiences with a field study, jointly conducted with colleagues at Sam Huston State University, informed one of the lenses we used to evaluate the relevance of studies. This meant that the specific issues we were seeing in our field study helped us recognize the relevance of studies from broader areas of technology implementation for our concerns in teacher preparation. For example, one of the early findings from our field study was that planning for the implementation of data dashboards was almost exclusively focused on technical aspects of the development and implementation of the dashboards themselves. The affordances and constraints of the organizational policies and practices in which the dashboard would be used received relatively little attention from dashboard advocates and planners. As we read studies from diverse fields such as Learning Analytics, Computer-Supported Collaborative Work, and Organizational Studies, we realized that this finding was by no means restricted to the institution in our field study; it was evident across almost all of the information technology implementation research we reviewed. The field study helped us see how important this problem was to the implementation process; the broader review helped us depersonalize this finding and recognize how pervasive it is across institutional contexts.

Procedures

We began our review by using Google Scholar to search for the studies identified through the term “data dashboard” in the domains of health science, business, and education. We used these leads as a start list to build a “snowball” sample of studies from each sector based on reviews of current journals in each field, and tracking relevant studies cited in those we found. Reading this
literature helped us refine and expand our search terms. For instance, in the business sector there is a literature on “enterprise resource planning” (ERP) which has similar design and implementation considerations to the data dashboards. In each of the subsequent sections of our review, we discuss the specific field terms we found relevant to our search. In all, we selected, read and analyzed 141 empirical studies and reviews of empirical research related to the implementation of data dashboards and related information systems in education, health sciences and business.

Each team member reviewed literature from one of the three sectors. We read each article and used low-inference coding to “tag” key ideas and findings in each article. Once we had read and coded 30-40 articles, we met to review and discuss themes that were emerging within and across the three literatures. We considered several descriptive and theoretical frameworks which might be used to integrate findings (e.g., the Domabedian “structure-process-outcome” model). We chose the PTO framework both because of its relatively strong theoretical connections with Cultural Historical Activity Theory, and because of its established utility in earlier work related to data use in teacher education (Peck & Davis, 2019; Peck, Cuthrell, Pointer-Mace, Sloan, & Lys, in preparation). Based on our preliminary analysis of cross-sector findings, we added a fourth analytic category, “Processes,” as described earlier and depicted in Figure 1.

We categorized subsequent studies as we added them to the database, using the PTOP framework to create “bins” of studies which contained findings related to each of the PTOP constructs. Findings from many of these studies fell into more than one analytic category. Those studies were included in our subsequent analysis of each category. We next undertook an inductive analysis of the studies within each category, and within each sector, in order to identify thematic findings that were helpful in addressing our research question. Again, we note that our goal was not to summarize and evaluate the state of theoretical and empirical knowledge in each of these literatures, but to identify thematic findings we thought would be useful resources for planning and
supporting the implementation of data dashboards in teacher education. While this is not an exhaustive literature review, we did find that the identified themes in each literature became quite robust as we aggregated empirical reports on the implementation of data dashboards and related information technology tools.
Appendix B. Full Findings

BUSINESS LITERATURE

Extant business literature concerning the implementation of data dashboards also referred to as enterprise resource planning systems (ERP) and enterprise systems (ES) tends to focus on identifying critical success factors (CSF) for implementing dashboards. As the name suggests, CSFs are conditions believed to increase the probability of project success (Lech, 2016). There is abundant literature that suggests some of the most important CSF are choosing key performance indicators (KPIs) that align to the organizations’ goals/objectives, organizational factors such as leadership and communication, and funding.

These three factors are correlated to one another in that one may affect how a factor influences another factor and ultimately the overall implementation of a dashboard. For example, an organization’s budget may limit the number of metrics the dashboard can display. Primary user is an infrequently referenced CSF. However, some within the business field have noted that a shift in focus from technology to people, will help to ensure dashboards implementation that is aligned with intended purposes (Few, 2007). This shift has propelled some dashboard creators and analysts to focus more on the visualization aspect of dashboards.

There needs to be a more robust conversation in the field about the socio-technical aspects of dashboards that goes beyond the technical design of a dashboard. The conversation ought to consider user beliefs, attitudes, data literacy, and much more. This section examines the implementation of dashboards in the business sector through the lens of people, tools, organizations, and processes.

1. People

Business Theme 1.1: User perceptions, attitudes and beliefs influence the ways in which they use (or don’t use) the dashboard.

Customer satisfaction is paramount for many organizations. When it comes to inter-organizational change, the organization needs to expand its focus from customer satisfaction to employee satisfaction. Employees’ perception of a tool, particularly their perceived usefulness of the dashboard, will drive how they choose to use—or not use—a tool the organization wants them to use. People’s attitudes tend to change throughout the process of change management (Amoako-Gyampah, 2007). Organizations need to be mindful of this and take necessary steps to plan for user-resistance due to their attitude and behavior.

Research indicates that direct managers are uniquely positioned to influence primary users’ attitudes and behaviors in the adoption of a dashboard (Rezvani et al., 2017). Studies have also shown that the users’ behaviors and organizational habits, are influenced by whether they see the dashboard as adding value to their workflow, i.e. useful (Matende & Ogao, 2013; Skorka, 2017). One strategy to assist in changing an individual’s habits is to make the dashboard compatible with existing technological and operating systems (Rajan & Baral, 2015).
Case in point **Amoako-Gyampah, K. (2007). Perceived usefulness, user involvement and behavioral intention: An empirical study of ERP implementation. Computers in Human Behavior, 23(3), 1232-1248.** Amoako-Gyampah (2007) surveyed employees in the business sector to investigate how their initial perceptions of usefulness and usability of a dashboard influenced their behavior and attitude towards a dashboard. The results of the survey revealed that users’ perceived usefulness of a dashboard directly influenced users’ intentions of using the dashboard. This study shows that user-intention to use a dashboard might depend more on how useful they perceive the dashboard than how easy it is to use the dashboard. Though ease of use was found to influence the use of a dashboard, employees’ perception of a dashboard had a stronger effect. A major conclusion of this study is that both the perceived usefulness and ease of use of the ERP system contribute significantly to a behavioral intention to use the technology.

**Further Reading**

**Business Theme 1.2: User confidence in their ability to understand interpret data affects dashboard use.**

Data literacy is the ability to understand data information (Wakeling et al., 2015). User’s inability to understand the metrics and reports dashboards generate can result in user’s resisting the intended dashboard use. Furthermore, if users are able to understand data, but are not confident in their ability to produce the desired result from understanding data, this can cause them to not use the dashboard. One’s ability and confidence to use data in a way that produces the user’s intended results are data efficacy. Rajan and Baral (2015) found that computer self-efficacy influences the use of dashboard systems. We posit that data self-efficacy - user’s belief, confidence, and ability to use, interpret, and understand data - is important when implementing dashboard systems. Organizations need to have mechanisms in place, such as professional development workshops, to increase user’s data literacy and data efficacy.

Case in point **Rajan, C. A., & Baral, R. (2015). Adoption of ERP system: An empirical study of factors influencing the usage of ERP and its impact on end user. IIMB Management Review, 27(2), 105-117.** Rajan and Baral (2015) proposed a conceptual framework based on ERP literature to identify and examine which factors influenced the use of ERP systems and their impact on the end-user. They developed and sent out a questionnaire to ERP end-users to test the hypotheses of their conceptual framework. Several domains were found to have an impact on end-users’ use of the dashboard. One of the most salient and impactful domains was computer self-efficacy. Computer self-efficacy was found to be a strong determinant of perceived ease of use and behavioral intention.

**Further Reading**

**Business Theme 1.3: User resistance—users’ passive and active expressions opposing dashboard implementation— can be due to a variety of factors, including alignment of dashboard metrics with user-values, and poor transparency and communication in DDB planning and implementation.**

According to Haddara and Moen (2017), user-resistance is one of the most important factors that influence the implementation of ERP systems. There are many different kinds of user-resistant groups and differing degrees to which an individual’s resistant behaviors (Klaus et al., 2010). However, not much attention is given to the ways in which user-resistance can negatively affect the implementation of ERPs.
People resist using dashboards if the metrics are not aligned to their goals, there are too many metrics, and/or if they feel the dashboard is imposed on them without consultation. Similarly, Lee, Lee, Olson, and Hwan Chung (2010) report resistance as a result of a lack of communication and transparency. Managers and executives need to have fluid communication with the primary users to ensure buy-in and that the primary user’s needs are met. It is important that there is a collaborative process in designing and implementing a dashboard. Understanding the various user-resistant groups and the reasons why people resist dashboards will help vendors, managers, and organizations develop strategies to meet the needs of people who may resist the implementation of a dashboard.

Case in point Haddara, M., & Moen, H. (2017). User resistance in ERP implementations: A literature review. Procedia Computer Science, 121, 859-865. There is ample research analyzing the effects of user-resistance on technology use. Haddara and Moen (2017) sought to uncover how much of that research pertained to the implementation of ERP systems. They found that the extant literature indicated user-resistance as one of the biggest challenges in large-scale information systems (IS) implementations, such as ERP systems, in organizations around the world. Furthermore, they found that user-resistance may lead to cost overruns, delays in project implementation, and underutilization of the system which will ultimately result in a low return on investment. Additionally, the literature they reviewed found that user-resistance occurs simultaneously from internal and external factors. This means that both the users (e.g. middle managers) and system features (e.g. user interface) should be considered simultaneously.

Further reading

2. Tools

Business Theme 2.1: DDB implementation in business is aided by the use of Key Performance Indicators - quantifiable measures that assess the success of the organization related to clearly specified goals.

Key performance indicators (KPIs) assist organizations in strategically reaching their intended goals/objectives (Pauwels et al., 2009). KPIs provide guidance and structure by measuring how close organizations are in reaching their desired goals. With that said, it is important for organizations to choose KPIs that align with their organization’s goals (Allio, 2012; Zouaghi & Laghouag, 2016). Allio states, “many dashboards suffer not from poor indicators, but from poor linkage with an actual strategy.”

Several studies suggest that choosing a limited amount of metrics is the best practice in designing a dashboard (Allio, 2012; Lech, 2016). Too many metrics can result in confusion and making the results hard to understand. Furthermore, given the multiple audiences the dashboard serves, the process of choosing the best metrics should be done democratically - involving executives, primary users, and other key stakeholders.

Case in point Skorka, A. (2017). Successful dashboard implementation in practice: How to overcome implementation barriers and ensure long-term sustainability. International Journal of Market Research, 59(2), 239-262. Skorka (2017) examines the implementation of dashboards and why some dashboards might not get used by primary users. He notes that one of the primary reasons dashboards are not used well is because users do not find them to be relevant to their day-to-day workflow. To avoid this dilemma, Skorka suggests managers and supervisors make sure information is relevant and has a direct impact on the user. To accomplish this, the key performance indicators
(KPI) need to be chosen by the managers and primary users democratically. Skorka gives the following analogy to illustrate the importance of choosing the right KPI:

Consider your daily commute to work. If you drive, you use the most widely used dashboard of all: the car. From left to right there is a display for engine temperature, RPM, current speed, fuel level, and, below the tachometer, the total number of miles driven over the life of your car. For your commute home, you really only need two out of those five readings: fuel level and speed. You probably check your fuel level before leaving. While driving, you will mostly check your current speed and alter it as necessary to road conditions and changing speed zones as you encounter them. It’s far less likely that you will pay much attention to your ongoing mileage or RPM. Why? Because neither piece of information is relevant for the actual journey. Even though a temperature that is too high could affect your journey, you won’t pay much attention to it because you have learned two lessons over time: the display has never changed; and, if the temperature is too high, a control light will warn you. As you can see, the speed display is the only one that actually leads to action. At least two out of the other five could be eliminated.

Further reading

**Business Theme 2.2: Access and use of data via DDBs can be supported (or inhibited) by the way data are represented visually.**

Dashboard visualizations summarize and display massive amounts of information in a simplified and transparent manner (Allio, 2012; Furmankiewicz et al., 2015). The success of a dashboard can be attributed to how the data is visualized (Skorka, 2017). The information can be visualized interactively, colorfully, and graphically - lines, points, and bars. According to Pauwels et al. (2009), it is important that visualizations are intuitive, appealing, and clear. Just as KPIs should be limited in number, visualizations should be easy-to-read yet contain rich information. Easy and dynamic summarization can be achieved through the use of gauges, charts, tables, and color-coding systems (Lehmann and Reibstein, 2006 as cited in Pauwels et al., 2009). Organizations need to be aware of the most beneficial ways to present data - level of precision and apt colors, component placement, and font size of pertinent information - that cater to their stakeholders' needs and interests.

**Case in point** Furmankiewicz, J., Furmankiewicz, M., & Ziuziański, P. (2015). Implementation of business intelligence performance dashboard for the knowledge management in organization. *Zeszyty Naukowe. Organizacja i Zarządzanie/Politechnika Śląska*, 82, 43-60. Furmankiewicz, Furmankiewicz, & Ziuziański (2015) discuss how dashboards that display data in an accessible manner can mitigate the complexity of knowledge management. Furmankiewicz et al. (2015) found that a properly implemented dashboard provides convenient access to pertinent information. This is due in part because of the visual, simple, and interactive form dashboard can provide to managers. When designing and implementing a dashboard, it is important that the uncluttered and eye-catching visualization is considered.

Further reading
**Business Theme 2.3: Dashboard implementation (use) is facilitated when the contents of dashboards are carefully aligned with the kinds of decisions users must make.**

Organizations are inundated with multiple reports, and this information adds to the complexity of decision making. Dashboards are intended to make reporting more accessible and more efficient. Users should be able to generate reports at any time. Furthermore, rather than merely providing a report card on performance, the dashboard should facilitate actions toward specific goals (Kawamoto & Mathers, 2007). Motta, Ma, You, & Sacco (2014) identify three kinds of reporting - exceptions/alerts (indicators defined and tracked), push reports (dashboard specified and initiated), and pull reports (user-specified and initiated). These kinds of reports help the primary user keep track of the KPIs and metrics, that they have predetermined as important for their organizational goals.

**Case in point** Sammon, D., & Adam, F. (2010). *Project preparedness and the emergence of implementation problems in ERP projects.* Information & Management, 47(1), 1-8. Sammon and Adam (2010) examined organizations’ preparedness to implement system-wide dashboards. They examined four case studies to discern what factored into implementation failure. In one of the cases, failure occurred during phase 1 of implementation as employees grew frustrated with the dashboard’s cumbersome reports that were not explicitly aligned to the organization’s goals (this could have also been attributed to the organization not choosing the appropriate metrics for reporting). Additionally, employee frustration was further exacerbated when technical teams lacked understanding of the data dashboard and were therefore unable to assist with reporting. Ultimately, implementation failure stemmed from the organization’s level of understanding of what was involved in designing and implementing a dashboard. It is important for organizations to choose the right kind of metrics that will ultimately influence the reporting. Lastly, organizations need to ensure that they are clear on their reporting needs and imbue that within the design and implementation of the dashboard.

**Further reading**

3. Organizations

**Business Theme 3.1: Organizational Re-engineering: In order to use dashboard technology effectively, organizations must make changes in their culture and infrastructure.**

Prior to employing a dashboard, organizations need to ensure they are cultivating a culture of data use. Along those lines, organizations should introduce the use of a dashboard as a tool for efficiency and organizational growth rather than a tool for monitoring and evaluating individual performance. This framing emphasizes the organization’s executive as supportive and may placate an individual’s reluctance to dashboard use (Lee et al., 2010). Skorka (2017) stresses three important factors in building this organizational culture: senior management support, dashboards alignment to the culture of the organization, and dashboard connection to organizational visions and missions. There needs to be a balance between a dashboard that enhances and changes the organization’s culture and a dashboard that aligns with existing organizational culture and values.
Case in point Nordin, N., & Adegoke, O. (2015). Learning from ERP implementation: A case study of issues and challenges in technology management. *Jurnal Teknologi, 74*(1), 57-62. In their single-case study of a small company installing an ERP, Nordin and Adegoke (2015) observed that participants saw the need to align their business processes to the ERP, rather than spending the money to customize a new system. The authors assert that this sort of organizational reengineering supports efficiency and productivity because it requires the business to adopt better business practices. They caution, however, that such change must be undertaken with considerable support from leadership in order to truly transform the organization.

Further reading

**Business Theme 3.2: Under-estimation of the initial cost, as well as the cost of sustaining a dashboard, can become a hindrance to dashboard implementation.**

Purchasing a dashboard can be an expensive investment (Chakravorty et al., 2016). To ensure organizations yield a substantial return on their investment, executives need to consider internal and external factors that may influence how much the organization spends on developing the dashboard (Ferreira & Kuniyoshi, 2015). An organization’s budget will ultimately define the scope of their goals. There needs to be a balance of primary user needs and what the organization can afford (Pauwels et al., 2009). Most cost overruns occur when the organization customizes the dashboard and then must train and update employees with those changes (Nordin & Adegoke, 2015). Several organizations’ have abandoned data dashboard implementation due to cost overruns and a decrease in the organization’s net income (Ram et al., 2013).

Case in point Chakravorty, S. S., Dulaney, R. E., & Franza, R. M. (2016). ERP implementation failures: A case study and analysis. *International Journal of Business Information Systems, 21*(4), 462-476. [https://doi.org/10.1504/IJBIS.2016.075256](https://doi.org/10.1504/IJBIS.2016.075256) In their study of an ERP implementation failure in a packaging manufacturing company, Chakravorty et al. (2016) describe how the costs of ERP implementation were much higher than initially anticipated. There were several causes for these overruns including prolonged leadership team training, technical complications with the system (i.e., conversion of the US system of measurements used by the company to the metric measurements use by the ERP), the need for increased staffing for transition between old and new systems, and the maintenance of the previous system during and after ERP implementation. The project began in January 2007. By June 2010 the company had invested $13.5 million in the new system, and the promise of ERP-generated savings the company had hoped to apply to implementation costs had gone unrealized.

Further reading

4. Processes

**Business Theme 4.1: Implementation should be understood as an iterative and multistage process. Failure to do so can result in implementation failure and/or abandonment.**

Dashboard implementation requires forethought and a well-defined strategy. Dashboard implementation is thought to happen in two ways: all at once or in phases (Nagpal et al., 2015). Depending on the existing culture and size of the organization the former strategy may work, however, most organizations will need to launch dashboard implementation in phases. Phases may include attending to socio-technical dynamics, organizational aspects, and technical elements.

Further reading

Business Theme 4.2: Research suggests that training and user education is connected to effective dashboard use, and lack of training may be linked to user resistance.
Ram, Corkindale, and Wu (2013) posit training users how to use a dashboard is a critical factor in the effectiveness of dashboard implementation. Good training and education can lead to dashboard being used effectively. A lack of training may lead to user reluctance—due to the cognitive load that sometimes accompanies learning a new tool. Abundant research has shown a high correlation between human training and organizational performance (Ferreira & Kuniyoshi, 2015; Ram et al., 2013).

Case in point Klaus, T., Wingreen, S. C., & Blanton, J. E. (2010). Resistant groups in enterprise system implementations: A Q-methodology examination. Journal of Information Technology, 25(1), 91-106. Klaus, Wingreen, and Blanton (2010) investigate the different types of user-resistance and management strategies concerning ERP implementation. Eight different user-resistant groups were identified from survey data. Despite the difference between the user-resistant groups, Klaus et al. (2010) posited that most groups would benefit from some level of training, specifically technical training (e.g. analytic or computer training).

Further reading

Business Theme 4.3: Leadership of dashboard implementation includes promoting a supportive data-use culture and making crucial decisions about ERP fit with organizational goals
Organizational change of any form necessitates effective leadership to plan, implement, and sustain the reform. Prior to implementation, leaders must consider numerous variables to decide if purchasing or building an ERP is in the best interest of the organization. To cultivate a work environment that prioritizes data-driven decision making and practices, leaders need to model data use and support employee’s data-use work. According to Lee, Lee, Olson, Hwan Chung (2010) leaders also need to create a supportive work environment to ensure the successful implementation of an ERP. Many organizations spend a significant amount of money and time on training leaders in technical use but rarely spend time ensuring leaders have the skills to articulate and support the use of ERP systems within their organizations. Some of these skills include ensuring employee satisfaction, motivating employees, and giving rewards for attaining organizational goals (Amoako-Gyampah, 2007; Rezvani et al., 2017).
Case in point Rezvani, A., Dong, L., & Khosravi, P. (2017). Promoting the continuing usage of strategic information systems. *International Journal of Information Management, 37*(5), 417–430. Rezvani, Dong, and Khostravi (2017) collected data from 192 users of ERP systems to determine if and how leaders influenced dashboard implementation. They found that transformational leadership behaviors of supervisors influenced users’ perception of satisfaction and perceived usefulness, while transactional leadership behaviors influence users’ ERP decision to continue using a dashboard by moderating the effects of user satisfaction and perceived usefulness on ERP decision to continue using a dashboard. This study suggests that the behaviors of managers influence primary users’ perception of dashboards, ultimately affecting dashboard implementation.

Further Reading
HEALTH LITERATURE

Literature in the field of health and medicine refers to intertwined initiatives that move health providers from work flows dependent on paper records toward workflows centered around computerized health information systems (HIS), also called health information technology (HIT). HIS and HIT are umbrella terms, covering a wealth of more specific technological projects such as Computerized physician order entry system (CPOE), electronic medical records (EMR) (also called electronic health records (EHR) or summary care records (SCR), and telemedicine.

1. People

Health Theme 1.1: User beliefs and perceptions that the tool will be both useful and useable can either facilitate implementation.

Sligo et al. (2017) found that “the most commonly cited facilitating factor in the human domain is the perception of the benefits of the innovation” (p. 91), including (1) perceptions that the technology was easy to understand, (2) users judgments of themselves as capable operators, (3) perceptions that the new system was better than previous systems, and (4) that users did not perceive the new system as time consuming (see also Gagnon et al., 2012). Boonstra and Broekhuis (2010) note, “those who are unwilling to use such an EMR system are skeptical about claims that EMRs can successfully improve the quality of medical practices” (p. 10), which suggests there may be a correlation between resistance to use and beliefs of usefulness. Gagnon et al. (2012) suggest that user training, “must focus on influencing the attitudes of participants toward the tool” (p. 248). They also state that active involvement of users in implementation can lead to feelings of ownership that are associated with perceptions of the systems’ usefulness (Gagnon et al., 2012).

Case in Point Greenhalgh, T., Stramer, K., Bratan, T., Byrne, E., Mohammad, Y., & Russell, J. (2008). Introduction of shared electronic records: Multi-site case study using diffusion of innovation theory. BMJ, 337, a1786–a1786. https://doi.org/10.1136/bmj.a1786. This study used a mixed methods case study evaluation across four early adopter sites of an SCR. The authors note that, at the time of their study, “users perceived the SCR to be an immature technology, described as ‘clunky,’ and to interface poorly with other information technology systems” (Greenhalgh et al., 2008, pp. 3–4). While most NHS staff “were broadly enthusiastic” about the SCR (Greenhalgh et al., 2008, p. 4), there was also a perception that parts of the model “were ‘too complicated to work in practice’” (Greenhalgh et al., 2008, p. 4). These user perceptions were seen as impacting use of the tool as “many people had given up using it ‘until it works better’” (Greenhalgh et al., 2008, p. 4).

Further reading
Health Theme 1.2: User fears or worries about the technology had to do with how the new tool would shift roles and power. These worries often appeared as the roots of “resistance” in the literature.

Across the literature, we saw concerns about how new technology would cause care providers’ roles to shift. In their literature review, Cresswell & Sheikh (2013) note at least two empirical pieces where there is a “perceived impact on dynamics of doctor–patient relationship,” (p. 77). Nilsson, Eriksén, and Borg (2016) note the group of care providers on the ground “felt that they had lost control over the foundations of their professional identity. They were confused about whether the patient really was in focus in their work, as long hours using the [tool], documenting their work, affected the patient relationship” (p. 793). The issue of loss of professional identity is closely linked to concerns around loss of professional autonomy. Boonstra and Broekhuis (2010) write, “With the implementation of EMRs, physicians are concerned about the loss of their control of patient information and working processes since these data will be shared with and assessed by others.” (p. 10). Likewise, Cresswell and Sheikh (2013) note “technologies which inadvertently undermine perceived social standing or professional autonomy are likely to be resisted by users” (p. 81).

Ultimately, Cresswell and Sheikh (2013) assert that “the majority of end-users are not averse to technology per se. However, they are likely to resist use of systems that are viewed as inadequate or, worse still, as interfering with their values, aspirations and roles” (p. 76).

Case in Point: Abraham, C., & Junglas, I. (2011). From cacophony to harmony: A case study about the IS implementation process as an opportunity for organizational transformation at Sentara Healthcare. The Journal of Strategic Information Systems, 20(2), 177–197. https://doi.org/10.1016/j.jsis.2011.03.005. In their case study of a networked healthcare organization (Sentara) in the United States, Abraham and Junglas (2011) aimed to understand how organizations transform through the implementation of an information system (IS). They note that the leadership needed to attend to the social and political dynamics of the organization as well as the implications for caregiver autonomy and power in the planning process and the implementation process. When the program was implemented, Sentara engaged in a process of continual improvement. For instance, when the requirement to code diagnoses in a particular way became a challenge to physician autonomy, the improvement process leadership team “incorporated clinicians in the redesign of the notes” (Abraham & Junglas, 2011, p. 187).

Further Reading

Health Theme 1.3: Users’ pre-existing technological skills may be related to successful implementation; however, lack of user skill could potentially be mitigated with training.

Users technical skills were widely referenced in the literature. Importantly, explications of why and how users’ skills affected implementation varied. Some studies noted that limited pre-existing technical knowledge and skills may lead to resistance from physicians (Boonstra & Broekhuis, 2010; Tsiknakis & Kouroubali, 2009). This is a problem in particular when vendors underestimate the level of computer skill users need in order to use the tool effectively (Boonstra & Broekhuis, 2010). Lack of technical skill can also ripple into other elements of implementation. Boonstra and Broekhuis (2010) noted that user proficiency with technology interacted with several other potential barriers to implementation including the tool’s perceived complexity, the time it takes to learn the system, the time it takes to enter data, the time spent with each patient, and interference with the doctor-patient relationship. Ingebrigtsen et al. (2014) noted the importance of leaders’ IT knowledge and its
connection to leadership vision, perceptions of the value of IT, and ability to endure adversities connected to IT adoption. While pre-existing comfort with technology is correlated with a better likelihood of implementation success, it can also be developed through training. Tsiknakis and Kouroubeli (2009) suggest that meaningful technological support and training leads to user efficacy. Callen et al. (2008) note that it is important to assess prior computer literacy and skills before implementation so as to design training for users who will need it.

**Case in Point** Greenhalgh, T., Stramer, K., Bratan, T., Byrne, E., Mohammad, Y., & Russell, J. (2008). Introduction of shared electronic records: Multi-site case study using diffusion of innovation theory. *BMJ, 337*, a1786–a1786. https://doi.org/10.1136/bmj.a1786. This study used a mixed methods case study evaluation across four sites that were early adopters of an SCR in Britain. The authors juxtapose two practices where technical skills varied. In one practice, “the senior partner was technically keen and capable, with strong links to his system supplier and the national programme for information technology. Informatics training for staff was prioritised, in-house expertise in information technology was high, and technical know-how circulated informally among staff” (Greenhalgh et al., 2008, p. 5). On the other hand, in a second practice “little in-house expertise in information technology existed. Indeed, this was not seen as a key skill needed by all staff but was delegated to the one ‘technical’ general practitioner” (Greenhalgh et al., 2008, p. 5). Not only did this practice experience delays and rely heavily on external support, “lack of relevant skills within the practice meant that little was learnt from encounters with technical support staff, and enthusiasm to develop internal networks to share technical learning was limited” (Greenhalgh et al., 2008, p. 5). Implementation may go more smoothly if there is pre-existing in-house technical knowledge and staff training is prioritized not only because the users will have more facility with the tool, but because the organization will be more able to build absorptive capacity.

**Further reading**

### 2. Tools

**Health Theme 2.1: One of the major ways that HIT and EMR design affects implementation has to do with its usability (how easy it is for users to pick up and use), its utility (how useful users find it as a tool), and its learnability (how easy users find it to learn to use the tool).**

In their literature review, Sligo et al. (2017) note that HIS tools “should be easy to use, clear and understandable; easy to learn to operate; flexible; and have easy navigation with easy to remember tasks...The technology should be intuitive, easily customised, have quality interface design and require little training” (p. 92). A subset of the literature notes specific design choices around information presentation such as color use and button placement (Dowding et al., 2015; Schall et al., 2017) can increase usability (Batley, Osman, Kazzi, & Musallam, 2011) and mitigate general doubt (Nguyen, Saranto, Tapanainen, & Ishmatova, 2014). Additionally, several surveyed articles noted design flaws, such as having many screens to click through or cumbersome mechanisms for fixing mistakes (Aarts et al., 2004), could dramatically increase the workload of providers (Cresswell, Worth, & Sheikh, 2012). In some cases an increase in workload shifted the perceptions of physicians who previously championed the tool (Aarts et al., 2004, p. 213). Berg (2001) notes “It is obvious that inadequate design of an information system (e.g. an inadequate user-interface) or its poor performance (e.g. slow response times) will reduce its chances of being implemented successfully” (p. 143). One challenge that led to these flaws was the complexity of the systems. In one case, users tied this complexity to the system being “unintuitive” (Jeppesen et al., 2018, p. 8).
Case in Point Jeppesen, E. M., Olsen, K. K., Richter, A., & Richter, S. (2018). User Attitudes and Support in Health Information Systems Implementation-the Case of the Danish Sundhedsplatformen. Research Papers, 105. In their discussion of the implementation of Sundhedsplatformen (SP), one of the largest public HIS in Denmark, Jeppesen et al. (2018) describe how, after SP went live, clinicians quickly saw how complex and thus “unintuitive” the system was (p. 7). The physicians noted that there were many ways to do a given task, which led to clinicians having to remember “so many different things” (Jeppesen et al., 2018, p. 8). While there were many ways to complete a given task, users also described the system lacking functionality, which led users to find workarounds to accommodate and adapt to local needs.

Further reading

Health Theme 2.2: IT tools such as dashboards are more successful when they are customized or customizable to the context in which they are used.
While the process by which a tool is built and/or customized for a particular context is important (and will be covered in the “Process” section), a strong theme runs through the literature that the tool itself must be able to be customized. Cresswell et al. (2012) assert that “the most important prerequisite for implementing complex EHRs was the existence of software that was usable, or could be ‘made usable’, and modified over time to suit the evolving needs of a variety of user groups” (p. 686). Jeskey et al. (2011) state, “If new technology is to be widely adopted then its design needs to fit its intended context of care” (p. 872) and Aarts et al. (2004) give an example of how a system designed in the United States had to be significantly adapted to work in the Dutch ambulatory clinics. All this being said, Berg (2001) cautions that the resulting tool must be balanced between “user-directedness and manageability” (p. 149). This is echoed in other literature about scope creep, where the scope of the project expands as it is developed — often beyond the bounds of what is possible to actually accomplish (Cresswell, Bates, & Sheikh, 2013; Cresswell & Sheikh, 2013; Sligo et al., 2017).

Case in Point Davidson, E., & Chiasson, M. (2005). Contextual influences on technology use mediation: A comparative analysis of electronic medical record systems. European Journal of Information Systems, 14(1), 6–18. https://doi.org/10.1057/palgrave.ejis.3000518. In their examination of technology-use mediation in two organizational case studies, Davidson and Chiasson (2005) discuss how various programs allow “the opportunity to ‘tweak’ a software technology without touching underlying code” (p. 8). They note that these methods of customization without coding caused developers to shift “from software design and coding to package selection, configuration, and integration with legacy systems” (p. 8) by assembling and integrating desired components. They also caution that this array of customizability “may overwhelm the organization’s ability to adopt all of its capabilities” (p. 8). While organizations may assume that customization means a “simple ‘plug-and-play’ implementation,” they “can be faced with substantial changes to procedures, practices, and work roles in order to accommodate the social design assumptions embedded in software” (p. 8)

Further reading

Health Theme 2.3: The new IT tool must be interoperable with pre-existing systems internal and external to the organization.
Interoperability—the ability of computer systems or software to exchange and make use of information—is essential to the utility of a given tool. If a new HIT is unable to communicate with
existing systems within the organization, or if it is unable to communicate with external data systems, it is unlikely to be used or useful. Interoperability is not without challenges, however. Sligo et al. (2017) assert that interoperability “bridges information gaps, [by] reducing redundant clinical procedures and increasing patient safety, accessing the full benefits of EHRs and potentially reducing costs” but “the quest for interoperability can cause compromises to be made that are not beneficial to a local HIS” (p. 92). Cresswell, Bates, and Sheikh (2013) note that, in the USA, commercial systems may be more attractive to health organizations in part because they are “likely to be interoperable due to common data standards and architectures” (e11). Nguyen et al. (2014) agree that “national standards on the interoperability of medical data systems would be a big step forward for small practices” in particular. Additionally, Stone and Yoder (2012) caution that supporting interoperability “is not inherently in the best interest of for-profit software firms because functionality allowing software systems from different vendors to communicate with each other represent an inherent threat to the vendor lock that many use as a key component of their business model” (p. 212)

**Case in Point**

Boonstra, A., & Broekhuis, M. (2010). Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. *BMC health services research, 10*(1), 231. In their literature review of perceived barriers to EMR adoption, Boonstra and Broekhuis (2010) cite a study by Valdes et al. that identifies “more than 264 unique types of EHR/EMR software implementations in use” (p. 9). They further explain, “The format of data varies among the different software packages and systems, in large part due to the lack of consistent data standards within the industry—this makes data exchange difficult, if not impossible between systems. This problem is more acute in smaller practices than in larger ones because of the relatively limited organizational resources such as expertise and experience” (Boonstra and Broekhuis, 2010, p. 9).

**Further reading**

### 3. Organizations

**Health Theme 3.1: Resources required for DDB implementation include initial monetary costs, costs for ongoing support, pre-existing infrastructure, time, and human capital.**

The adequacy of required resources is a well-documented challenge in HIT implementation (e.g. Boonstra & Broekhuis, 2010; Sligo, Gauld, Roberts, & Villa, 2017; Vishwanath & Scamurra, 2007). In our review, we identified several types of resources that could be required. Monetary cost—which applies to both initial and maintenance costs of a HIT (Boonstra & Broekhuis, 2010)—are the most referenced resources in the literature. These costs include “purchasing, coordinating, monitoring, upgrading, and governance” (Boonstra & Broekhuis, 2010, p. 4) as well as the financial cost of ongoing support and training for users (Jeppesen et al., 2018; Vigoda et al., 2011). There is also a monetary cost associated with developing and maintaining the necessary infrastructure for the HIT to function. The new HIT system must be able to assimilate into the existing technology infrastructure of the organization (Aarts et al., 2004; Ammenwerth, Iller, & Mahler, 2006; Nguyen, Tapanainen, & Ishmatova, 2015; Sligo et al., 2017; Vigoda et al., 2011), which may entail HIT customization costs or infrastructure upgrade costs. Another resource prevalent in the literature is time, both the time to train staff members, the time to enter data, and the time it takes to implement...
the HIT (Boonstra & Broekhuis, 2010). The final resource is human capital—people within the organization who are trained to provide support (Davidson & Chiasson, 2005).

**Case in Point** Davidson, E., & Chiasson, M. (2005). Contextual influences on technology use mediation: A comparative analysis of electronic medical record systems. *European Journal of Information Systems, 14*(1), 6–18. https://doi.org/10.1057/palgrave.ejis.3000518. Because of their focus on technology-use mediation, Davidson and Chiasson (2005) focus on how “organizational resources are used for contextualizing software, adjusting practice, reinforcing system uses” (p. 14). They recount how, in one of their case studies, the organization paid ten physicians for an additional ten hours per week as well as reassigned nurses, pharmacists, and other clinicians to the work of installing the system, and training other users. After implementation, “these groups transformed into permanent organizational resources to resolve procedural issues (adjustments) and to carry out episodic changes” (Davidson & Chiasson, 2005, p. 11). The authors note that these individuals were able to take on this role because, “as fully trained and clinically licensed clinicians, [they] understood the language and context of use, and they had legitimacy and influence among other clinicians” (Davidson & Chiasson, 2005, p. 11).

**Further reading**

**Health Finding 3.2: An organization’s size and structure, including its tendency toward siloed practice, has implications for the implementation of HITs.**

The size of the organization seems to impact how HITs are implemented. Larger organizations tend to have more resources available to them, which eases implementation and enables ongoing support (Boonstra & Broekhuis, 2010; K. Cresswell & Sheikh, 2013; Davidson & Chiasson, 2005). However, larger organizations also require more time to “select, purchase and learn a system, [and] convert and enter data” (Boonstra & Broekhuis, 2010, p. 11). Another organizational structure that appeared in the literature was the tendency toward silos of practice (e.g. Hersh, 2004). Abraham and Junglas (2011) describe the “fragmented” (p. 183) and “disjointed” (p. 182) nature of practice within the network being studied. This proved challenging to implementation in that “getting [stakeholders] engaged to even form the coalition across disciplines was difficult because clinicians tended to not understand the value in focusing on any area other than their own” (Abraham & Junglas, 2011, p. 182). The implementation of HIT may further this siloing effect because often information is restricted to some people and inaccessible to others due to how permissions are structured (Lluch, 2011).

**Case in Point** Abraham, C., & Junglas, I. (2011). From cacophony to harmony: A case study about the IS implementation process as an opportunity for organizational transformation at Sentara Healthcare. *The Journal of Strategic Information Systems, 20*(2), 177–197. https://doi.org/10.1016/j.jsis.2011.03.005. Within their case study of a networked healthcare organization (Sentara) in the United States, Abraham and Junglas (2011) describe the challenges of silos. In planning for HIT implementation, it became clear “how little each stakeholder group (i.e., physicians, nurses, technicians, and administrators) knew about each other’s’ involvement in the care process” (Abraham & Junglas, 2011, p. 188). Additionally, “getting [the stakeholders] engaged to even form the coalition across disciplines was difficult because clinicians tended to not understand the value in focusing on any area other than their own.” (Abraham & Junglas, 2011, pp. 181–182). The CIO of Sentara navigated these “clashes in cultural norms in the organization” (p. 188) by “develop[ing] two coalitions based on function and purpose of organizational stakeholders who could help, plan, champion, and govern compliance for the transformation effort” (Abraham &
Junglas, 2011, p. 181). The first coalition was formed prior to HIT acquisition, and the other was formed prior to HIT implementation. Both coalitions were formed with the intention to create support across all levels of the organization. Abraham and Junglas (2011) note that “this demonstrated true collaboration that could transcend from planning throughout the entire implementation effort” (p. 182).

Further reading

**Health Theme 3.3: Mismatch between existing workflow and the workflow of the HIT can create barriers to implementation.**

Boonstra and Broekhuis (2010) described one study where “92% of physicians felt EMR use did disturb communication with their patients. Physicians have to turn to the computer to complete electronic forms during the encounter, and this can be time consuming especially when they suffer from limited computer skills” (p. 11). Boonstra and Broekhuis (2010) continue, citing a second study where “some physicians reported that they sometimes stop using EMRs because hunting for menus and buttons disrupts the clinical encounter” (p. 11). Gagnon et al. (2012) note, “A frequent reason for unsuccessful implementation reported in included studies was that the information system was not a very good fit with work practices or daily clinical work” (p. 244). Even when the product is meant to improve the workflow, it “can introduce secondary workflow disruptions, making it less likely that late adopters and laggards will embrace the new technology.” (Stone and Yoder, 2012, p. 210). Stone and Yoder (2012) suggest choosing an EMR system “that emulate[s] existing workflow when possible” because “research has demonstrated that the more closely EHR systems emulate existing paper-based workflows, the more satisfied nurses will be with the new technology” (p. 210).

**Case in Point** Aarts, J., Doorewaard, H., & Berg, M. (2004). Understanding implementation: The case of a computerized physician order entry system in a large dutch university medical center. *Journal of the American Medical Informatics Association, 11*(3), 207–216. [https://doi.org/10.1197/jamia.M1372](https://doi.org/10.1197/jamia.M1372). In their examination of a CPOE system in a large Dutch medical center, Aarts et al. (2004) describe how the new system impacted workflow: “Soon after the implementation, clerical users found that retrieving and entering patient data took much more time because each screen would allow them to handle only a limited amount of data. For most tasks, many more screens now had to be worked through. Also, when making typing errors, they had to go back in the pathway and redo a part of, or even the whole, transaction. Furthermore, they discovered that data they held to be essential vanished after a few screens” (p. 212). Additionally, crucial information such as patient ID number did not remain on the screen as it did in the previous system. The result is what the authors call “a severe slow-down of work processes, which created chaos at the ambulatory clinical department desks” (Aarts et al., 2004, p. 213).

**Further Reading**

### 4. Processes

**Health Finding 4.1: The implementation of HIT can be conceptualized as a socio-technical process, where organizations both change the HIT and are changed by the HIT.**

Across a subset of articles, IT implementation was conceptualized as a socio-technical process. This was sometimes articulated as mutual transformation or mutual shaping (Aarts, Doorewaard, & Berg, 2004; Berg, 2001; Bossen, 2007; Cresswell, Worth, & Sheikh, 2012; Davidson & Chiasson, 2005) and emergent change (Aarts et al., 2004; Currie & Finnegan, 2011; Heeks, 2006; Sheikh et al., 2011;
This subset of articles argues that implementation cannot be fully planned for or controlled (Aarts et al., 2004; Berg, 2001), because “the implementation process is highly unpredictable” and “was influenced by contingencies that were not expected and certainly not planned for” (Aarts et al., 2004, p. 215). However, these authors argued that not being able to control the process could lead to positive results for the organization in that it can change the way the organization operates. Berg (2001) suggests that “IS implementation should not be run as a ‘mere’ technical project. It should be managed as a process of organizational development, in which IT is drawn upon as a strategic asset to transform organizational structures and routines, and further the organization’s goals” (p. 148). Part of the power of seeing HIT implementation as a socio-technical process may lie in the tendency of implementation to reveal unseen factors in the organization (Abraham & Junglas, 2011; Ammenwerth, Iller, & Mahler, 2006; Bossen, 2007). Abraham and Junglas (2011) describe how Sentara created a “paradigm shift” when they “used the IS implementation to break open the organization and reveal its inner workings.” They assert that HIT implementation was “the vehicle for that awareness and change to take place, which can be attributed to the promotion of project awareness created from common knowledge” (p. 188). In the end, Berg (2001) argues “Overlooking the fact that PCIS implementation will fundamentally affect the health care organization’s structures and processes is one core reason for implementation failure” (p. 147).

Case in Point Berg, M. (2001). Implementing information systems in health care organizations: Myths and challenges. *International Journal of Medical Informatics, 64*(2), 143–156. [https://doi.org/10.1016/S1386-5056(01)00200-3](https://doi.org/10.1016/S1386-5056(01)00200-3). Berg (2001) describes an EMR used for care of hypertensive patients—initially, designers, in collaboration with researchers, designed an interface to facilitate the researcher’s data collection. However, physicians found the system “too ‘rigid’ to capture the essence of a patient’s visit;” for example, the sets of codes developed by the researchers “could not capture that the core reason of the patient’s visit was his increased anxiety about his hypertension, for example, triggered by the recent death of his father” (Berg, 2001, p. 151). Thus, physicians developed a workaround, using the small free text section to enter information. While the heavy use of the one unstructured data field created issues for the researchers, the author suggests not trying to eliminate unstructured usage of the free text field and instead, recommends “mak[ing] this field more readily accessible and enlarg[ing] it” and regrouping the structured items “so that the required back-and-forth between the fields would be designed to facilitate the evolved usage as much as possible” (Berg, 2001, p. 151), thus demonstrating how tool and users might adapt to one another.

Further reading

Health Theme 4.2: Ongoing training and support are widely recognized as essential to successful IT implementation. Research also suggests that — as a part of this support — users are engaged in an iterative and ongoing process of feedback and customization to ease implementation and facilitate training. Adequate training and time are widely recognized as essential to effective HIT implementation (Cresswell & Sheikh, 2015; Sligo, Gauld, Roberts, & Villa, 2017). While training and support are often conceptualized as happening during the “roll out” phase, user involvement can occur during the conception and design stages as well as the field testing and prototyping of the tool (Cresswell & Sheikh, 2013; Lluch, 2011; Sligo et al., 2017). Some authors articulate this sort of engagement as a process of continual improvement or iterative design (Abraham & Junglas, 2011; Batley et al., 2011;
Jeskey et al., 2011; Sligo et al., 2017). Berg (2001) asserts “It is not enough to ‘include’ a few potential users in the project group, to have them negotiate system specifications, and to discuss implementation plans and the achievement of socio-technical ‘fit’ in meetings once every so often” (p. 148) and recommends those implementing a HIT use “Ethnographic methods, studying the detailed social organization of actual working practices through participant observation methods and in-depth interviews” (Berg, 2001, p. 148). Similarly, Jeskey et al. (2011) suggest undertaking “exploratory action-feedback approaches” to “assist in assessing the real-world effects and risks of implementation.” and “inform decision-making about if, when and how subsequent implementations might occur” (p. 872). Other authors recommend forming interdepartmental collaborative teams as a means to engage stakeholders across different areas of expertise (Abraham & Junglas, 2011; Nguyen, Eikebrokk, Moe, Tapanainen, & Dao, 2016; Takian, 2012). Ultimately, involving end-users throughout the process can lead to tools that are better designed to meet user needs (Berg, 2001; Nguyen et al., 2016; Sligo et al., 2017).

Case in Point Abraham, C., & Junglas, I. (2011). From cacophony to harmony: A case study about the IS implementation process as an opportunity for organizational transformation at Sentara Healthcare. The Journal of Strategic Information Systems, 20(2), 177–197. https://doi.org/10.1016/j.jsis.2011.03.005. The networked healthcare organization Sentara engaged in an ongoing process of improvement during implementation. The authors write, “Another objective of the improvement activities at Sentara was to promote learning for both the administration and users. The intent was to seek new areas to improve and to pass on baseline knowledge of IS capabilities learned during the initial or subsequent training sessions” (Abraham & Junglas, 2011, p. 190). The training wasn’t just for the users to learn the system; it was meant to inform administration about additional ways they could improve and what users might need. The authors further assert that as a result, the users regarded the IS as a means for learning and used it to answer equivocal or complex questions that were not previously raised” (Abraham & Junglas, 2011, p. 190). This suggests that this method of training and involving users in querying the tool changes the use of the tool in practice.

Further reading

Health Theme 4.3: Leadership can be thought of as a distributed process throughout levels of an organization, and a representative leadership team may be better able to predict and address issues that arise in implementation.

While several authors suggest the importance of top-down leadership structures to support communication and strategic vision (Berg, 2001; Cresswell & Sheikh, 2013; Sligo, Gauld, Roberts, & Villa, 2017), others note specific cases where national top-down initiatives caused local leaders to disengage (Ingebrigtsen et al., 2014) or a lack of user involvement (Sheikh et al., 2011). Cresswell and Sheikh (2013) note that in complex structures with great degrees of hierarchy, such as large healthcare organizations, “senior leadership and lead professional (or ‘champion’) support, resulting in greater ownership surrounding implementation activities” (p. e81). The importance of the champion was noted across the literature (Boonstra & Broekhuis, 2010; Gagnon et al., 2012; Greenhalgh et al., 2008; Nguyen, Tapanainen, & Ishmatova, 2015; Ludwick & Doucette, 2009; Nguyen, Eikebrokk, Moe, Tapanainen, & Dao, 2016; Sligo et al., 2017), and Cresswell and Sheikh (2013) explain that they can act as “act as ‘boundary spanners’, bridging the gulfs that often exist between and within information technology staff, management and clinicians” and can “facilitate the re-design of workflows, provide adequate training and support to users, and highlight problematic issues” (p. e81). This conceptualization of distributed leadership acknowledges the importance of
individuals, but also takes into account the need for leaders at multiple levels of an organization (Ludwick & Doucette, 2009; Moen, 2003; Yusof, Stergioulas, & Zugic, 2007). Hunter et al. (2015) suggest that “engaging individuals at all levels in the change effort by adopting a distributed or shared model of leadership may optimise the chances of the change initiative being maintained especially in complex settings” (p. 21).

Case in Point Cresswell, K., & Sheikh, A. (2013). Organizational issues in the implementation and adoption of health information technology innovations: An interpretative review. International Journal of Medical Informatics, 82(5), e73–e86. https://doi.org/10.1016/j.ijmedinf.2012.10.007. In their review of organizational factors that impact HIT implementation and adoption, Cresswell and Sheikh (2013) attend to a variety of things leaders—beyond taking on the roles of champions—can do to ease the initial disruption of implementation. This includes proactively decreasing individual workloads during implementation to make additional time available to users and timing implementation for a period with no other major upheavals at the organizational level. The authors also note that leaders should consider “the avoidance of ‘scope creep’, interoperability considerations, and the appropriate implementation approach suited to the technology and organization in question (for example, a slow and incremental ‘soft-landing’ or a one-off ‘big bang’)” (Cresswell & Sheikh, 2013, p. e81) as well as planning for contingencies if the technology should fail.

Further Reading
EDUCATION LITERATURE

The literature on data dashboard implementation in education is more recent and more limited than in the business and health sciences fields. In fact, recent cross sector comparisons of organizational capacity to use new information technologies for learning and improvement, suggest that education is among the fields least prepared to implement and benefit from these technologies (Heath & Fulcher, 2017; Norris & Baer, 2013). Institutions of higher education represent particularly challenging contexts for implementing data dashboards due to their decentralized organizational structure, shared-governance policies, and cultural histories of institutional autonomy (Bologa, Muntean, Sabau, & Scorta, 2009; Macfadyen, Dawson, Pardo, & Gašević, 2014; Pollock & Cornford, 2006). Given the very limited number of studies of dashboard implementation, our review in this area includes some studies drawn from broader literatures related to data use and organizational change.

1. People

Education Theme 1.1: Internal motivations related to inquiry and program improvement are more likely to support and sustain effective DDB implementation and use than those organized around external pressures or rewards.

Several studies suggest the nature of motivation underlying efforts to data dashboards implementation and related IT tools is significant—particularly in the context of sustaining efforts over time. One important dynamic has to do with the motivational effects of implementation efforts driven by external pressures (e.g., state policy mandates, grant funds and associated requirements) versus those grounded in local priorities for inquiry and program improvement (Peck, Gallucci, & Sloan, 2010; Sutherland, 2004). These motivational conditions may also vary across individual units within an organization. For example, Lonn, Aquilar, and Teasely (2013) observe that “most institutional technology departments are run like a for-profit business, where products and processes are managed in strict pipelines and outcomes are measured in number of users served and terabytes used” (p.248). In contrast, research on faculty engagement with policy initiatives related to data use suggests that inquiry and improvement of practice are more powerful motivation for data use in both k-12 and higher education settings (Davis & Peck, in press; Sutherland, 2004). Understanding the motivational dynamics underlying the participation or nonparticipation of faculty, staff and academic leaders in efforts to implement data dashboard technologies is critical to designing supports for the implementation process.

Case in Point Ahn, J., Campos, F., Hays, M., & DiGiacomo, D. (2019). Designing in context: Reaching beyond usability in learning analytics dashboard design. Journal of Learning Analytics, 6(2), 70-85. Ahn, Campos, Hays, & DiGiacomo (in press) describe a DDB development and implementation project that was explicitly conceptualized around the challenges of integrating data dashboard design practices with analysis of local work practice. Their report is based on an 18 month period of data collection in research-practice partnerships involving four research universities and local P-12 school partners. Authors analyzed the ways teachers made sense of data as presented on the DDB during development. A finding of particular relevance to our interest in motivational dynamics affecting DDB implementation was teacher’s resistance to visual representations of data.
that implied there was “one right answer” to questions about practice. The authors observed that: “indicating more or less ‘correct’ choices meant interpreting data a priori for practitioners, imposing and external entity who was telling teachers they were wrong and were being watched. Instead of fostering collective negotiation of meaning from classroom data to drive reflection and ideas for improvement, we introduced an experience of external accountability and monitoring” (p. 77)

Further reading

**Education Theme 1.2: Meaningful data dashboard use requires data literacy, however many teachers and teacher educators have limited knowledge and experience with interpreting metrics and related data representations from dashboards.**

Mandinach (2012) and others have observed that effective use of data dashboards requires data literacy, including both an understanding of basic issues related to measurement and statistics and the ability to go “beyond the numbers and their statistical properties to make meaning of them” (p.73). Moreover, barriers to data dashboard use related to data literacy have been reported for higher education faculty (McCoy & Shih, 2016) as well as K-12 teachers (Mandinach & Gummer, 2013). Based on their study of a campus-wide initiative to facilitate university faculty engagement with institutional data and data analytics, McCoy and Shih (2016) conclude that universities and colleges not only need to focus on the development of analytics professionals, they must also begin to address the faculty’s role in the data analytics process given that learning analytics and learner analytics depend “upon the ability of a teacher to quickly make sense of data visualizations presented in learning dashboards” (Pea, 2014, p. 40).

**Case in Point** Schifter, C., Natarajan, U., Ketelhut, D. J., & Kirchgessner, A. (2014). Data-Driven Decision-Making: Facilitating Teacher Use of Student Data to Inform Classroom Instruction. *Contemporary Issues in Technology and Teacher Education, 14*(4), 419-432. In this study the authors drew on several fields of knowledge and practice, including organization science, management and government to develop, implement and evaluate a professional development model to support teachers in using a new DDB as a tool for instructional improvement. The authors recognized the potential of the dashboard as a technical tool for providing teachers with relevant and useful data for improving instruction, but they also recognized the importance of developing new work practices that supported teachers to use this new tool. A significant feature of the professional development (PD) model Shifter, et al. (2014) used to support new work practices was the use of teacher teams to analyze, interpret and plan specific instructional activities for their own students. This “organic” approach to PD emphasized an entire cycle of data analysis, interpretation and action planning; it contrasts with what was characterized by K-12 teachers in another study as a “cognitive dump” approach, in which information about the affordances of the dashboard were presented, but not integrated into the practical activity of instructional planning (Cho & Wayman, 2012).

**Further Reading**

**Education Theme 1.3: Educators hold diverse views of the meaning of “data dashboards,” and these views strongly affect their engagement with dashboard implementation.**

A pervasive assumption, underlying the theory of action implicit in contemporary accountability policies, is that new information technologies will be useful and used as tools for program improvement. Research from multiple fields of professional practice suggests this is an
oversimplified view (Piety, 2013). Practitioner attitudes and beliefs about the purposes of data and data use have a significant effect on whether and how they use information technologies, including DDBs (Ahn, et al, 2019; Cho and Wayman, 2014). A particularly salient dimension of these beliefs has to do with the perceived tensions between accountability and program improvement (Wall, Hirsh, & Rogers, 2014). Other research underscores the importance of how potential DDB users perceive the educational validity of the measures used as input to the dashboard.

Case in Point Cho, V., & Wayman, J. C. (2014). Districts’ efforts for data use and computer data systems: The role of sensemaking in system use and implementation. Teachers College Record, 116(2), 1-45. Cho & Wayman (2014) studied the ways in which teachers’ interpretations of the meanings of “data” and “data use” affected their use of information technologies designed to support data-based decision making. Using interview and observational data, the authors compared practitioner interpretations of these term’s meanings across three school districts. One dimension on which perspectives differed had to do with views about the purposes of data use. In one district these views were strongly aligned with school and district accountability goals, while in another the focus was more strongly centered on the uses of data for improvement of instruction. Practitioner views about data in one district were also found to vary by role, with administrators more likely to view data as a tool for improvement, while teachers saw data and data use primarily as policy tools aimed at increasing external reporting and accountability. The authors concluded that: “technologically deterministic perspectives tend to assume that technologies have predefined “effects” on work… Contrary to these perspectives, we did not find that simple access to functionalities resulted in use. Rather, notions about data use served as an interpretive lens through which certain features were favored, while others were ignored or rejected” (p.25).

Further reading

2. Tools

**Education Theme 2.1: Measures that are close to practice are more likely to be perceived to be useful, and more likely to be used by practitioners.**

Data dashboards rely on input from a variety of potential data sources and measures. The extent to which DDB tools are used is affected by the alignment of these measures with the practical activities of users (Verbert, et al, 2013). These activities may be expected to vary by organizational role: what is “close to practice” for a dean, superintendent or department chair will not necessarily be useful for a faculty member, field supervisor, or mentor teacher. Several of the most promising examples of DDB implementation describe dashboards that utilize measures of well-established local value (Fernandez, et al., 2015; Swan, 2009).

Case in Point Swan, G. (2009). Tools for data-driven decision making in teacher education: Designing a portal to conduct field observation inquiry. Journal of Computing in Teacher Education, 25(3), 107-113. Swan (2009) describes the process and outcomes of a dashboard development and implementation process in a teacher education program. The author begins by identifying a local problem of practice—the observation that rich artifacts of teaching practice for teacher candidates were routinely collected in electronic portfolios, but not used in ways that seemed to afford opportunities for learning and program improvement. The authors developed a dashboard tool that allowed program faculty to “see” patterns of performance within and across teacher candidates, as well as evaluate the reliability and validity of supervisor field observation ratings for candidates. These data were used by faculty to identify issues of concern at both the level of individual
candidates, and for the program. The author comments on the relevance of the DDB as a tool for moving the tacit organizational knowledge into more explicit and public view, enabling previously archived but unused information to function as a resource for program improvement.

Further reading

Education Theme 2.2: There are tensions between local DDB needs and uses, often focused on unique measures and program improvement goals and general DDB uses, often focused on program comparisons and accountability goals. Interoperability between data systems is essential to making DDBs useful across institutions, and to achieving economies of scale in technology development. However, interoperability is often in tension with pressures for tool modification and adaptation related to the needs of local work practices (Shifter, et al, 2014). These tensions are endemic to the work of technology implementation, and negotiating them in ways that result in technology use is one of the central tasks of implementation.

Case in Point Pollock, N., & Cornford, J. (2004). ERP systems and the university as a “unique” organisation. Information Technology & People, 17(1), 31–52. Pollock and Cornford (2004) studied the implementation of a university-wide information technology and management system—what they and others refer to as an “enterprise resource planning” tool, in a large urban university in the UK. Using ethnographic methods, the authors followed the process of mutual and ongoing negotiation of project goals, implementation and outcomes that took place between the central university administration, departments across campus, and the ERP vendor over a period of three years. Among the tensions that surfaced throughout the implementation process, was “the choice between conducting expensive ‘customization’ work on standard solutions or undergoing unwanted organizational change in adapting their practices to models of work and organizational process embedded in the software.” (p.33). They found that these tensions often became unmanageable, leading to implementation of default generic “solutions” that required local workarounds, including labor-intensive maintenance of both old and new systems of information management.

Further reading

3. Organizations

Education Theme 3.1: Organizational policies and practices that support collaboration are essential to achieving meaningful use of data dashboards for program improvement. Collaboration is at the core of program improvement simply because meaningful organizational changes in teacher education are not just about the individual pieces of a program, but also about how these fit together to create a coherent whole (Hammerness, 2006). Collaboration is particularly important in university contexts, where de-centralized organizational structures, administrative policies, and disciplinary boundaries often contribute to deep “silos” of work practice. As Swan (2009) observed in one program: “The supervision process at the study site is very decentralized. There are no shared procedures between programs, and little, if any, group planning is done. With no formal mechanisms to promote knowledge sharing, the socialization and externalization processes are unlikely to take place” (p.112).
Case in Point  

**Davis, S. & Peck, C. (in press) Using data for program improvement in teacher education: A study of promising practices. Teachers College Record.** Davis and Peck (in press) studied ten “high data use” programs of teacher education situated in higher education institutions that varied in size, institutional mission, and state policy context. Using data collected via interviews, examination of local program documents and site visits conducted over a two-year period, the authors found that each of the programs had developed specific organizational structures and policies designed to support collaboration across faculty, and across program units. These included regular scheduling of data use activities in departmental meeting agendas as well as periodic cross-program “data days,” designed to provide time and space for analysis and interpretation of data across program units within the college and, in some cases, in units across the university campus. While data dashboards were powerful tools for aggregating or disaggregating data related to these programs, the actual use of the data presented via dashboards for program decision making was dependent on allocation of substantive time and opportunity for interpreting the meanings of the data presented, and deliberation of their implications for action.

**Further reading**

**Education Theme 3.2: Universities have unique organizational features that affect DDB implementation.**

Traditional universities are by design highly insulated from external control—particularly with respect to issues of curriculum and instruction, which are largely controlled by faculty. In addition, university administrative structures are highly de-centralized, with academic departments and colleges operating largely independently from one another, and from central administration (Bologa, et al, 2009). These policies and related work practices are themselves grounded in a distinct institutional culture, often articulated in terms of faculty autonomy and “academic freedom” (Macfadyen & Dawson, 2012; Wall, Hursh, & Rodgers, 2014). Taken together, these organizational characteristics suggest that implementation strategies that emphasize “top down” policy decision making may be more difficult to carry out in universities than in institutions with more centralized authority and decision making.

**Case in Point**  

**Pollock, N., & Cornford, J. (2004). ERP systems and the university as a “unique” organisation. Information Technology & People, 17(1), 31-52.** Pollock and Cornfeld (2004) used workplace ethnographic methods to study the implementation of a university-wide information management system in a large British university over a three-year period. The authors describe how the University’s organizational structure, policies and practices made it difficult to manage the number and diversity of organizational changes required to implement the information system as designed, even with substantial central administration support. This resulted in a) the emergence of “work around” solutions, often entailing maintenance of both old and new technology and work practices, or b) the reshaping of university policy and practice to fit the newly introduced technologies. The authors noted that, in some contexts, the university personnel began to identify with implementation of the new technology as an achievement that distinguished their university from others. They concluded that in these cases the technology itself began to reshape the identity of the university.

**Further reading**
Education Theme 3.3: Differences in organizational context matter to implementation.

While educational organizations, including universities, share some features related to their readiness and capacity for DDB implementation (Norris & Baer, 2013; 3.2 above), each also exists in a unique context, including both specific institutional history and differences in local social and political conditions and dynamics. Important differences in organizational priorities, policies and practices may also be evident across units within a single university (Bologna, et al, 2009; Pollock & Cornford, 2004). This finding is consistent with research from other organizational sectors (Fitzpatrick, 2003). It suggests that many of the most significant challenges for DDB implementation and use are unique to the specific institutional contexts and, thus, require local contextual assessment and strategic planning. This does not mean that regularities do not exist in the kinds of challenges arising across institutional contexts, but rather that the specifics of these matter, particularly with respect to the kinds of local negotiations that must be undertaken to achieve implementation and use of new information technologies in educational organizations.

Case in Point Cho, V., & Wayman, J. C. (2014). Districts’ efforts for data use and computer data systems: The role of sensemaking in system use and implementation. Teachers College Record, 116(2), 1-45. Cho & Wayman (2014) used data from interviews and observations to compare practitioner perspectives on the purposes of data use tools and policies adopted in three school districts. They found that educators’ views about data and related information technologies varied in each of the districts. In one district, practitioners viewed the purposes of data use primarily through an accountability lens, while in a second district practitioners saw data primarily as a tool for individualizing and improving practice. In these districts, educators’ views about the purposes of tools and processes related to data use were relatively consistent across schools, and across central administration and building personnel. In a third district, however, the researchers found that views about data use varied depending on professional role, with both central office and building-level administrators interpreting data use as a tool for improving practice, while teachers saw these activities as primarily about mandated external reporting and accountability. As might be expected, these teachers’ views were associated with their very limited use, and sometimes outright rejection of the information technologies. The Cho & Wayman study suggests that differences in practitioner values and beliefs about data use and related information technologies vary substantially across school district contexts, and that these differences carry substantial implications for the kinds of supports needed to achieve widespread use of the technological tools districts in which these districts had made investments.

Further reading

4. Processes

Process themes from the research literature in the educational sector are dynamic and highly contingent. The processes we identify below unfold over time, in ways that are highly intertwined with one another, and with the specifics of local context and history. We describe process factors that appeared to be influential across multiple contexts, without making the assumption that they will be constituted, much less carried out, in the same way. In fact, adaptation of these general process approaches to the specifics of local context appears to be critical to their success.
**Education Theme 4.1: Leadership practices strongly affect organizational change processes in education, including those related to implementation of DDBs.**

Leadership practice has been well documented as a crucial variable affecting organizational change in education, including initiatives related to using data for program improvement (Anderson, Leithwood & Straus, 2010). Several important dimensions of leadership practice have been identified in the K-12 literature, including the development of a shared leadership vision related to DDB use (Cho & Wayman, 2012), the distribution of leadership responsibilities across multiple levels of the organization (Lachat & Smith, 2005; Sloan, 2013), and the orchestration of organizational resources to support faculty/staff participation in data use activities (Datnow, Park, & Kennedy-Lewis, 2013). While many of the findings of the K-12 research literature provide useful perspectives on the challenges of DDB implementation in higher education, Bologna, et al (2009) observe that “in universities we find a large number of very different groups, having different objectives and interests, acting in different fields, so that communication is more difficult” (p. 442). There is some evidence to suggest that, because of these de-centralized authority structures, DDB implementation strategies in higher education must attend with particular care to the values, motives and practices of faculty and staff in these settings, building rationale and local supports for implementation from “the ground up” (Davis & Peck, in press; Swan, 2009).

**Case in Point** Davis, S. (2019). Engaging faculty in data use for program improvement in higher education: How leaders bridge individual and collective development. Manuscript in review. Using case study data collected in three “high data use” teacher education programs, Davis (in review) describes the challenges academic leaders face in building a motivational context for faculty engagement with data use work related to program improvement. Based on faculty interviews and field observations conducted over a three-year period, Davis identifies a variety of “bridging practices” leaders used to link individual and collective motivation and learning processes related to data use and program improvement. These included reframing program narratives around data use to emphasize collective aspirations for program improvement, creating organizational policies that aligned individual and collective goals (e.g., creating an internal small grants program support program-focused research), and aligning data use work with local faculty and staff values. Evidence from the three programs suggested that, over time, these leadership practices were associated with a strengthened sense of “collective self-efficacy,” wherein program faculty and staff felt better able to respond to external accountability pressures, including those for data use, in ways that did not abandon local values.

**Further Reading**

**Education Theme 4.2: Implementation planning and support processes are often focused on technical aspects of DDBs, with relatively little attention to significant challenges of implementation related to organizational work process, policy, and culture.**

Studies of data dashboard design and implementation processes generally show that the bulk of planning and design time, attention and resources are spent on development of technical tools, with relatively less attention devoted to the social/organizational context in which those tools are intended to be used (Ahn, et al, 2019; Brown & Duguid, 2000; Macfadyen & Dawson, 2012; Peck & Davis, 2019; Wise and Vytasek, 2017). These studies suggest that increased attention toward understanding, anticipating, and planning for the organizational change processes involved in successful implementation of information technologies, including data dashboards, would enhance the likelihood of achieving implementation goals.
Case in Point Macfadyen, L. P., & Dawson, S. (2012). Numbers are not enough. Why e-learning analytics failed to inform an institutional strategic plan. *Journal of Educational Technology & Society, 15*(3), 149-163. Macfadyen & Dawson (2012) studied the implementation of a learning management system (LMS) at a large research-intensive university. Data generated through the system afforded the institution a means of measuring its current state and future progress towards an institutional vision for teaching and learning with technology. In addition to these learning analytics data, the authors collected participant observation data in meetings of committees responsible for moving the institutional process of LMS implementation forward. The authors found that deliberations and decision-making within these committees focused almost exclusively on technical questions relating to “ease of migration.” Critical interpretation of the implications of data describing the institution’s current and future implementation of the LMS, particularly with respect to using the data for instructional and program decision making was almost entirely absent. The authors commented on these findings: “While there is an obvious imperative to ensure that any new enterprise technology is functional, scalable and reliable, an exclusive focus on technology integration issues, in the absence of development of a pedagogical vision, quickly neutralizes the likelihood that learning analytics data may catalyze organizational change with a focus on the student experience and learning outcomes. A focus on technological issues merely generates “urgency” around technical systems and integration concerns, and fails to address the complexities and challenges of institutional culture and change” (p. 159).

Further Reading
## Appendix C. Further Reading

### Business Themes | People

<table>
<thead>
<tr>
<th>Business Theme 1.1</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Business Theme 1.2</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Business Theme 1.3</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>

### Business Themes | Tools

<table>
<thead>
<tr>
<th>Business Theme 2.1</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Business Theme 2.2</th>
<th>Supporting Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Theme 2.3</td>
<td>Supporting Literature</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------</td>
</tr>
</tbody>
</table>

Return to themes

### Business Themes | Organizations

<table>
<thead>
<tr>
<th>Business Theme 3.1</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>

Return to themes

<table>
<thead>
<tr>
<th>Business Theme 3.2</th>
<th>Supporting Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Theme 4.1</td>
<td>Supporting Literature</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------</td>
</tr>
</tbody>
</table>

**Business Theme 4.2** | Supporting Literature |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Theme 4.3</td>
<td>Supporting Literature</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------</td>
</tr>
</tbody>
</table>

Return to themes

---

## Health Themes | People

<table>
<thead>
<tr>
<th>Health Theme 1.1</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>
| **User beliefs and perceptions** | ● Boonstra, A., & Broekhuis, M. (2010). Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. *BMC health services research, 10*(1), 231.  
● Cresswell, K., & Sheikh, A. (2013). Organizational issues in the implementation and adoption of health information technology innovations: An interpretative review. *International Journal of Medical Informatics, 82*(5), e73–e86.  
https://doi.org/10.1016/j.ijmedinf.2012.10.007  

Return to themes
<table>
<thead>
<tr>
<th>Health Theme 1.2</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>

Return to themes

<table>
<thead>
<tr>
<th>Health Theme 1.3</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>

Return to themes
## Health Themes | Tools

<table>
<thead>
<tr>
<th>Health Theme 2.1</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>

Return to themes

<table>
<thead>
<tr>
<th>Health Theme 2.2</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>
Health Theme 2.3 | Supporting Literature

Interoperability

- Boonstra, A., & Broekhuis, M. (2010). Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. *BMC health services research, 10*(1), 231.


Health Theme 3.1 | Supporting Literature

Resources


- Boonstra, A., & Broekhuis, M. (2010). Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. *BMC health services research, 10*(1), 231.

<table>
<thead>
<tr>
<th>Health Theme 3.2</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>
| **Organizational structure** | - **Boonstra, A., & Broekhuis, M.** (2010). Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. *BMC health services research*, 10(1), 231.  
- **Cresswell, K., & Sheikh, A.** (2013). Organizational issues in the implementation and adoption of health information technology innovations: An interpretative review. *International Journal of Medical Informatics*, 82(5), e73–e86. [https://doi.org/10.1016/j.ijmedinf.2012.10.007](https://doi.org/10.1016/j.ijmedinf.2012.10.007)  

Return to themes

<table>
<thead>
<tr>
<th>Health Theme 3.3</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>
- **Cresswell, K., & Sheikh, A.** (2013). Organizational issues in the implementation and adoption of health information technology innovations: An interpretative review. *International Journal of Medical Informatics*, 82(5), e73–e86. [https://doi.org/10.1016/j.ijmedinf.2012.10.007](https://doi.org/10.1016/j.ijmedinf.2012.10.007) |
<table>
<thead>
<tr>
<th>Health Theme 4.1</th>
<th>Supporting Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Theme 4.2</td>
<td>Supporting Literature</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------</td>
</tr>
</tbody>
</table>

Return to themes

<table>
<thead>
<tr>
<th>Health Theme 4.3</th>
<th>Supporting Literature</th>
</tr>
</thead>
</table>

## Education Themes | People

### Education Theme 1.1 Supporting Literature

**Motivation Matters**


### Education Theme 1.2 Relevant Literature

**Data Literacy**

<table>
<thead>
<tr>
<th>Education Theme 1.3</th>
<th>Relevant Literature</th>
</tr>
</thead>
</table>
### Education Themes | Tools

#### Education Theme 2.1

<table>
<thead>
<tr>
<th>Practice-relevant measures</th>
</tr>
</thead>
</table>

#### Education Theme 2.2

<table>
<thead>
<tr>
<th>Local vs generic use</th>
</tr>
</thead>
</table>

---

Return to themes
### Education Themes | Organizations

<table>
<thead>
<tr>
<th>Education Theme 3.1</th>
<th>Relevant Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Collaboration</strong></td>
<td></td>
</tr>
</tbody>
</table>

Return to themes
# Education Theme 3.2

**Relevant Literature**

<table>
<thead>
<tr>
<th>Universities as organizations</th>
</tr>
</thead>
</table>

Return to themes

# Education Theme 3.3

**Relevant Literature**

<table>
<thead>
<tr>
<th>Context Matters</th>
</tr>
</thead>
</table>

Return to themes
## Education Themes | Processes

<table>
<thead>
<tr>
<th>Education Theme 4.1</th>
<th>Relevant Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education Theme 4.2</td>
<td>Relevant Literature</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
Appendix D. Comprehensive list and access information for studies included in the review

https://doi.org/10.1197/jamia.M1372

https://doi.org/10.1016/j.jsis.2011.03.005

https://doi.org/10.18608/jla.2019.62.5

https://doi.org/10.1108/10878571211257159

https://doi.org/10.1186/1472-6947-6-3


https://doi.org/10.18608/jla.2014.11.7

https://doi.org/10.1197/jamia.M2468

https://doi.org/10.1504/IJBIS.2016.075256

https://doi.org/10.1057/ejis.2008.49


https://doi.org/10.1136/amiajnl-2013-001684

https://doi.org/10.1145/2110363.2110441


Gagnon, M. P., Desmartis, M., Labrecque, M., Car, J., Pagliari, C., Pluye, P., ... & Légaré, F. (2012). Systematic review of factors influencing the adoption of information and communication
https://doi.org/10.1007/s10916-010-9473-4


https://doi.org/10.1108/02635571011020340


https://doi.org/10.1016/j.ijmedinf.2011.09.005


https://doi.org/10.1016/j.ijmedinf.2008.06.005


http://dx.doi.org/10.18608/jla.2016.33.10


https://doi.org/10.1080/00461520.2012.667064
https://doi.org/10.3102%2F0013189X12459803


https://doi.org/10.1136/amiajnl-2013-001762

https://doi.org/10.1016/j.jbi.2003.09.019


https://doi.org/10.1109/LISAT.2015.7160177


https://doi.org/10.1016/j.ijinfomgt.2017.04.008

Sammon, D., & Adam, F. (2010). Project preparedness and the emergence of implementation
problems in ERP projects. *Information & Management, 47*(1), 1-8.

https://doi.org/10.1097/cin.0000000000000325

Schifter, C., Natarajan, U., Ketelhut, D. J., & Kirchgessner, A. (2014). Data-driven decision-making:
Facilitating teacher use of student data to inform classroom instruction. *Contemporary Issues in
Technology and Teacher Education, 14*(4), 419-432.

Sheikh, A., Cornford, T., Barber, N., Avery, A., Takian, A., Lichtner, V., Petrakaki, D., Crowe, S.,
Marsden, K., Robertson, A., Morrison, Z., Klecun, E., Prescott, R., Quinn, C., Jani, Y.,
Implementation and adoption of nationwide electronic health records in secondary care in
England: Final qualitative results from prospective national evaluation in “early adopter”
hospitals. BMJ, 343(7829), d6054–d6054. https://doi.org/10.1136/bmj.d6054

implementation barriers and ensure long-term sustainability. *International Journal of Market
Research, 59*(2), 239-262. https://doi.org/10.2501%2FIJMR-2017-017

82


https://doi.org/10.1016/j.anclin.2011.05.010


https://doi.org/10.1504/IJBIS.2016.075720
Additional References


