Decentralizing Data Through Decision Support Systems: The Impact of Increased Access to Data on Decision-Making

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This study examines the impact of a new Decision Support System (DSS) on decision-making in a community college in California. It looks at how attitudes and behaviors about data and their use were impacted by the implementation of a new DSS. The study found that the decentralization of data, through the DSS, produced a shift in terms of an increased desire to use data as well as an increase in the actual use of data that could be used to address and guide decision-making. Additionally, while the ways in which decisions were approached revealed a more proactive use of data for decision-making, the study also revealed legacy organizational patterns, structures, and norms that need to be addressed in order for the institution to more effectively build and support an emerging culture of inquiry over time.

Introduction

Higher education institutions have been under a great deal of pressure to increase their use of data and information (Wells, Silk & Torres, 1999). As a result, many of these institutions responded by developing Decision Support Systems (DSS) with the aim of increasing access to data for staff and faculty throughout the institution (Banta, Rudolph, Van Dyke & Fisher, 1996; Frost, Dalrymple & Wang, 1998). Recent research has suggested that easier access to data within higher-education institutions affects how people use that information (Chan, 1999; Pickett & Hamre, 2002). This study examines the impact of a new DSS on decision making within one community college district. It looks specifically at how perceptions, attitudes, and behaviors about data and its uses were impacted by the implementation of the new DSS. Our interest in choosing to look at the impact of the DSS on decision-making was to find out whether increased access to data had an effect on the way individuals approached decision-making and inquiry. This study builds on existing research by illustrating how one community college's implementation of a DSS increased data access and use and helped to create the capacity for a culture of inquiry. It also builds on prior research by showing how decision support systems are inevitably situated within a history of institutional structures and attitudes, which

need to be factored into an institution's ability to support a culture of inquiry.

Literature

Institutions of higher education have been recognized as complex and high-pressure decision-making environments (Harmon, 1986). The use of decision support systems emerged as a response to the increasing demand for direct data access within higher education institutions (Frost, Dalrymple, & Wang, 1998). Decision support systems have historically brought together data resources in order to better facilitate data use on multiple levels (Metz & Cosgriff, 2000). Additionally, recent advancements in computer technologies in business and government have allowed non-specialists to make better use of data analysis (Hallett, 2000).

On most campuses, prior to the introduction of a decision support system for users across the institution, data had been concentrated within central administrative offices. As a result of this centralized structure, these offices often experienced an overload of requests for data from individuals, thereby creating an unmet need for data (Frost, Dalrymple & Wang, 1998; Serban, 2002; Wells, Silk & Torres, 1999). At the institutional level, the implementation of a decision support system helps to ameliorate this problem by placing data directly in the hands of those who need it. This comes at a time when more people are being asked to respond to inquiries based on data rather than on intuition (Wells, Silk & Torres, 1999).

Some research suggests that decision support systems help users develop more sophisticated means of analyzing and interpreting data (Harmon, 1986; National Forum on Education Statistics [NFES], 2006). This ease of access can stimulate users to look at data with a new sense of familiarity and understanding; data is regularly at their disposal and not simply handed to them without an understanding of the context in which the data were retrieved. In turn, users may be encouraged to pose new questions and queries, thus stimulating ongoing investigation throughout the institution. As a result, some studies have shown that better access to data stimulates ongoing questions, greater demands for data, and more sophisticated analysis (Frost, Dalrymple, & Wang, 1998; Hallett, 2000; Harmon, 1986; NFES, 2006).

But as other works suggest, reflective and proactive decision-making requires more than just increasing access to data and technology. As Petrides and Nodine (2005) concluded in a study of performance-driven practices in 28 urban school districts, encouraging a culture of information sharing, inquiry and continuous learning is central to the effective application of data and information toward problem-solving and improvement (see also Petrides, 2004). As the social informatics literature reveals, cultivating key aspects allow individuals and technology to work successfully—namely, the social context of which technological infrastructure is a part (Gasser, 1986; Jewett & Kling, 1991; Kling, 1999). Kling (1999) defines social context as matrix of social relationships characterized by incentive systems for using, organizing and sharing information at work. Drawing on a comparison between two firms' different uses of the same document management tool, Kling illustrates how technology use varies in terms of organizational incentives and tacit assumptions about how technology should be used (Kling, 1999). Thus, Kling, as well as subsequent scholars working within this vein (e.g., Lamb & Sawyer, 2005), illustrate how information technologies are situated within a social and cultural context that shapes individuals' own understanding and use of those technologies.

Methodology

This study is based on the analysis of a series of in-depth interviews with administrators, faculty, and staff at a community college in California. Interview participants were selected from a non-random sample that was determined by identifying a cross section of administrators, faculty and staff at City College of San Francisco (CCSF) who had used the district's DSS between June 2001 and February 2002. Because we wanted to look specifically at the shift in data retrieval since the DSS had been introduced in 2001, participants who had been employed by CCSF for less than two years were eliminated from the sample.

In order to obtain a spectrum of diverse users with a broad range of data needs and level of use, the final selection of participants was made from the larger group of DSS users across a wide range of departments and positions within the college. Participants were grouped and selected based on the number of times they had accessed the DSS in the nine

months prior to the start of the study in February 2002, as well as whether they had used it over a period of time, as opposed to having used it multiple times in only one particular month. This allowed for a cross section of DSS users, ranging from those who had used the system only once during the nine-month period, to those who had used it more regularly on an ongoing basis. While this cross section of individuals was meant to provide a representative sample of DSS users, the study did not find notable differences between the groups in terms of their data use behaviors and attitudes. Table 1 shows a summary of the final groups of 27 participants, organized by the number of times that each group logged onto the DSS from June 2001 through February 2002.

The log files used to select the sample did not provide information on the amount of time per session that each person had used the system, their level of comfort using the system, or the purpose of their search. However, these questions were used to inform the interview protocol. In addition, we knew if a particular person had directly accessed the DSS, but the log files did not provide an indication of whether users accessed the system for themselves or for another person. In other words, there were likely others who were end-users of the data in the DSS, but may not have been part of the sample of people who actually logged onto the DSS. For this reason, a category was created to include the quasi-user, an individual who used the data from the DSS without actually logging on to the system. One person in this category was included in the sample for this study.

Participants were interviewed using the critical incident technique. This technique is used in order to elicit examples and outcomes about actual behaviors and relies upon specific recall, thereby bypassing hypothetical situations (Flanagan, 1954). This was done in order to understand, retrospectively, if attitudes and behaviors about data and its uses had changed since the introduction of this new desktop research tool. The interview protocol asked participants to recall specific incidents when they sought to gather or retrieve student data through the currently available technologies—both before and after the implementation of the DSS. This technique was used to capture information about the context of those incidents, and finally whether the incident had a successful or unsuccessful outcome. This enabled us to take a snapshot of what types of data had been requested over the past year and, most importantly, to identify the processes undertaken by information-seekers to obtain the data they needed.

After the interview data were transcribed, a set of comprehensive codes was developed. Atlas.ti, a qualitative data analysis software tool, was used to associate codes with pieces of text, to search these codes for patterns and recurring themes, and to construct classifications of codes that reflected the conceptual structure of the underlying data. This study provides an analysis of significant themes from the 27 critical incident interviews as a way to illustrate the range of data-use behaviors and attitudes brought to light by to the DSS implementation.

The Setting

City College of San Francisco (CCSF) is a large, urban community college district with 2,400 employees; it serves more than 95,000 students annually on over nine campuses. In 1998, CCSF invested in a new information system that gave individual departments the ability to access data from their desktops via a new college intranet. The system was used primarily by departments that had hired technical specialists who could download data and information on an as-needed basis. However, because most departments could not afford specialists, they had to either

Table 1. Catagories of Interview Participants

Use of DSS Between 6/01–2/02	Sample Size
Used DSS during 4 or more months (high use)	12
Used DSS during 3 months (mid-level use)	8
Used DSS during 1–2 months (low-level use)	6
Did not access DSS themselves, but were users of DSS data	1
Total interviewed	27

make a request directly to the institutional research office, wait until a programmer generated the report for the department, or navigate a complex set of rules to access the data via the information system (Gabriner, 2001). As a result, data needs were often unmet, leaving individuals to base their decisions on old data or intuition.

The institutional research office, similar to other research offices across the state of California, is responsible for reporting data on a growing number of state and federal mandates that involve institutional accountability. In 2001, the institutional research office implemented the new decision support system, a web-based interface that linked directly to a data warehouse that contained student data from Spring 1998 to the present. This new system was implemented as a result of efforts by the institutional research office to provide a streamlined process for campus users to directly access student data.

To help ensure that the DSS would be used, the institutional research office staff prepared a series of presentations for groups of department chairs and deans from all of the college's divisions, demonstrating the DSS with customized examples chosen to resonate with the subject-specific and functional interests of each group. A user's manual was also provided, which offered different scenarios to illustrate how the DSS could be used. A feedback process was also installed, where eventual users could indicate how the system was working for them, which in turn would be used for potential updates to the DSS.

Findings

The Pre-Decision Support System Environment

Prior to the introduction of the DSS, it was difficult to directly access student data. Therefore, as might be expected, the research office was often required to broker the data—offering the technical expertise it took to access the data stored in the existing system, and providing data to individuals who did not possess the necessary expertise or training to do it for themselves. The result was that individual requests had to wait in a queue for the research office to fulfill. As one participant explained of the data acquisition process prior to DSS, "Research was able to [provide] a zip code report so we would know

where the bodies came from at least. So we could still go to institutional research and ask for some of the information, but it just took more time."

In some cases, the centralization of data prior to the DSS was reported to have lead to, or perhaps contributed to, a mistrust and avoidance of data use—for when data were requested, they were simply handed down from administrative offices without a clear sense of how the data had been defined or aggregated. This led to suspicions that certain "agendas" may have been attached to the data. Said one participant:

> Well, before we had access to things like DSS, it was all given to us and it was given to us usually from sources that we didn't trust in the first place, [from sources] that we believed had agendas and that we were not getting the whole picture about enrollments, among other things.

When asked specifically what they did before the introduction of the DSS when they wanted to use data for decision-making, several participants reported that they either did not use data, or they used data that they already had, which in some cases, had been produced years before. Explained one participant, when asked how they accessed student information prior to the DSS:

> We didn't. I used 1993 data… That's what I did. I had an information sheet about students… it was a paper survey and that was sort of the data that we were using and just hoping that it didn't change, [that it] hadn't changed too much.

Other participants mentioned that they were often forced to "guesstimate" prior to the DSS since the data they needed was not available to them. Said one participant, "Yeah. It's a lot better than before we had it, when we just had to make guesses". Thus, to complete tasks such as scheduling, these participants relied on their recollection of what had happened over the past few years instead of being able to look at an analysis of prior enrollment data. Manual counts were another popular strategy reported. Explained one participant:

> We would do a manual count. If we wanted to know how many [students were from a certain demographic], we would sit there and count the

number of [names demographic] students and figure out the percentage, and I didn't know of any other way of doing that.

All of these factors together—the dependence on the institutional research office, the lack of timely and accessible data, and the suspicious nature of the previously available data—created an opportunity within CCSF to make a contribution to the community of data users through the DSS.

Impact of the DSS on Decision-Making

One of the main questions that we were interested in answering in this study was how access to the DSS data impacted decision-making throughout the district. Specifically, what types of data did people need in their work, and how did access to these kinds of data that were available in the DSS impact their ongoing work and their perceptions about data use? We found that participants used the DSS for a number of specific purposes. These centered on being able to track enrollments, make arguments for increased resources (including new hires and additional funding), and finally, to provide what one participant called "artillery" for arguing a point or making a case with others. While enrollment management was most frequently cited as the reason a participant used the DSS, having the ability to substantiate one's argument with data was cited most often as the reason someone used the DSS in the first place. For example, there were several instances of participants' reported success in acquiring a more complete picture of how enrollments were taking shape at the beginning of a semester. One participant in particular spoke of how this had affected her decision to open up new sections when needed, and how she was better able to serve her students because of this. She said:

> We know in a general way that we turn students away, that sometimes we just don't have enough seat space for everyone who wants to take the classes. But putting a finger on where the most unmet demand is was basically impossible before the Decision Support System started tracking it for us.

Another participant described being able to take basic demographic data and turn it into something that would be useful to the development of her program. Through an analysis of the data available in the DSS, she was able to determine the demographics for those who were traditionally drawn to the program. She said:

> Well, the one thing that did change is I finally was able to come up with what I thought was a fairly good profile of who the students in my program are. And I'm currently sort of looking at some of that information and re-evaluating it and attempting to write up a profile of who they are. Knowing who they are allows me, in some ways, to serve them better.

Once she was able to more accurately determine those students who were attracted to the program, she was then able to feed that information back into her current work by recognizing the need to market the program to a wider audience. She explained:

> It also reveals who is not being served by our program… So it tells me that we may have to step up efforts with recruitment and/or just plain encouragement of people who don't meet that profile—telling them about opportunities that may be available, making sure that they're comfortable with the work, and addressing their needs in some other way.

This particular case illustrates the importance of how access to data can impact the organization as a whole through the behavior of individuals who are motivated to improve the functioning of their own departments or programs by using data to inform decision-making.

Other cases of DSS data use cited by the participants revealed how having data readily available allowed them to address problems in new ways. For example, one participant explained how before the DSS was available, his program did not have the ability to simultaneously address a specific question about the program, much less locate the data that would enable them to answer the question and respond to it. Before the DSS, the program had to rely on the institutional research office to provide them with data, which not only placed a barrier between them and the data, but also delayed their decision-making capability. He said:

> It wasn't like I could sit down and say gee, I'm wondering if we should put more classes out in

the [location] area. 'Cause in order to get that information, they had to do extra work so I had to make sure it was a question that I really needed to have answered. Whereas now you can kind of just put in there different combinations and I think it sort of opens the door to looking at things differently. I mean, [DSS affects] how we do scheduling and where we put our classes, where we put teachers, what time we put classes.

Furthermore, several participants described ongoing efforts to fix "bad" or inaccurate data that had been in the system for several years. They also reported how the cycle of correcting and using the data had produced a renewed awareness and interest in using data. The following example, indicative of a shift that participants described, illustrates this increased interest in data use and the accompanying shift from using data in reaction to a problem to proactively questioning issues within the organization:

> First of all, you can use the information in a reactive way, which is the way most people used it. And then you can use it in a proactive way if you're trying to substantiate a vision and sell it—it's important for it. So in a reactive way questions would be—why am I noticing a change in overall student performance? Then you go in, you look at GPAs, you look at English proficiency levels. You look at what high schools they came from. You see if there is a new geographical or socio-economic mix from the zip codes, right? You could look at how many classes they're taking per semester. What else could you do?

In this example of pre-DSS, using data in a more reactive fashion entailed taking notice of a change, looking to find out what the problem might be, and then determining what might help explain it. Presently, having access to data in the DSS, such as GPAs and levels of English proficiency, allows participants to use data more proactively, indicating a shift toward a culture in which data are beginning to be used to anticipate problems, rather than attempting to solve them after the fact.

Toward a Culture of Inquiry

As indicated in the last section, the DSS, did in fact, contribute to the capacity of the organization to provide a more democratized form of data, partly relieving tensions around how data had been dissemi-

nated in the past, and inspiring new decision-making behaviors for users. However, further analysis of the interview data revealed that in addition to changes in the way that data were perceived and drawn upon, there was also evidence that the institution still had structural issues that needed to be resolved in its quest to more fully support a culture of inquiry. For example, even with better access to data and new attitudes on behalf of some users, historical patterns of data control and use within the organization were reportedly still making it difficult for those who did use data to support their decision-making. One participant described his experience in trying to support a decision with the use of data, reporting that even when data were used to support an argument, there was still resistance to making decisions that required doing something that was different from the way it had been done in the past—making the on-going desire to encourage the use of data in decision-making that much more difficult to sustain. He said:

> It's like a whole series of what they call 'past practices' here have kind of woven things together so when you come in and you try to change it or deal with it, 'Well, no, in the past we've always done it this way' and they even have the word 'past practice' they put on it, so therefore you can't change it, so if you say, I want to do an alternative calendar where we do 16 weeks instead of 17 weeks and here's the data that shows it would be positive for students in terms of retention… they're going to say, 'I see the data, but I don't believe it, besides that, in the past we've always done it this way.' So you're going to have to overcome that resistance from that level.

Another participant described the information environment in terms of organizational silos, or independently functioning segments of the organization that collect their own data and do not re-circulate these data back into the system as needed. As one person said, the trick is to "get [people] out of their silos and start working together," so that the information systems, like DSS, can begin to include and reflect the data for the entire institution. As the participant explained:

> I think that DSS is there and people are looking at it online and it's been there for six months, but it's not like a universal system that everybody's using. I think part of it is that we have these silos

that people work in and they feel that what they do in the silo is somewhat independent of the rest of the world, their silos. So even if they decided to ignore DSS and a whole number of things, they probably believe that they could still survive for years doing what they've been doing. So our thing is to try to figure out a way to get them out of their silos and start working together and to use tools that are there whether it's technology or numbers or whatever.

Other participants spoke of "rigid" organizational patterns that they still faced in trying to work within the system, and how this structure hindered them from making the necessary changes in their environment. Said one participant when asked about strategies used to make points or arguments to the administration:

> You know, I'm not…how could I say this? I'm not in a position to make arguments to the administration, let's put it that way… Particularly in this department, they have a very hierarchical nature and you cannot, you will be in trouble, really in major trouble if you go and do things on your own without having to go directly to the chair. Now other departments might be a little different, but not this particular department. Everything has to be—I guess it's, it's very rigid.

Also reported was the concern that decisions were not made according to data or informed analysis, and that the current patterns of decision-making gave the impression that whatever data one did have would not make a difference because of alliances in place within the program. Said one participant:

> The program is run by an administrator and it's sort of like a family where the parents are the administrators and they make the decisions, and so the children or the well-intentioned cousins or siblings or whoever can suggest all they want, but the final decision isn't [theirs].

Lastly, there was mention of the inability of the institution to more closely examine the mechanisms underlying the processes that support the old way of doing things. As one participant explained, there is the need to dig more deeply to look at what might be keeping students from succeeding, instructors from performing, or other parts of the institution from thriving:

> Largely it's educating others that there may be a problem, that on the surface it appears that the college is moving along smoothly. We have healthy transfer numbers. But our task is to dig deeper and to see if in fact that's true and we're seeing that there might be some common themes that run across our student body. And so it's, again, a matter of understanding 'is it true, is there any truth to the fact that there are some underlying problems?' and number two, educating those who might have a vested interest in this or a concern about increasing our performance. And so again, educating our senior administrators, that kind of thing.

Thus, there is a concern that it is the legacy culture, not the legacy data systems that may prevent the shift to a more proactive culture around data use. This finding highlights the importance of the institution's need to educate the individuals within it so it can support a culture that encourages reflective questioning and proactive decision-making.

In short, while the DSS appeared to helped to create the capacity for a culture of inquiry at the college—such as the reported increase in people's interest in asking questions about their departments and programs as a way to improve how they served their students—there are still structures and norms in place that support a more reactive approach to decision-making. Therefore, allowing its emerging culture of inquiry to flourish alongside the use of the DSS may necessitate, as the social informatics literature has suggested, an in-depth consideration of the social and cultural context within which data use and technology are situated.

Conclusion and Implications

This study supports prior research that suggests that decision support systems in higher education institutions can increase data access and facilitate data use across organizations. In turn, this increased access can lead to a greater demand for data and perhaps more sophisticated analyses among the users. The introduction of the DSS at CCSF, which was equally available to all faculty and staff, appears to have been accompanied by a shift in people's perception of data, in terms of helping to substantiate claims for additional resources, as well as to help dismantle, albeit slowly, pre-existing negative attitudes

concerning the use of data. By introducing a decentralized research tool, City College of San Francisco has been able to introduce a new model of data use that allows users to be in control of the data they collect and use.

On the whole, the experiences at CCSF demonstrated that changes in perceptions, attitudes, and behaviors stemming from the decentralization of data can help pave the way toward a culture that supports reflective questioning and new ways of approaching problems. Importantly, the CCSF case also helped to illustrate that in order for this type of culture to become more pervasive throughout the institution, considerations should likely be made for the social context and structures that the data and its decentralization technology are situated within. Specifically for CCSF, this might entail addressing the reported hierarchical decision-making structures, work silos, and the legacy culture of reactive questioning—through district-wide, multi-level trainings on decision-making and reflective inquiry practices.

For CCSF as well as other higher education institutions, a more comprehensive view on data decentralization that takes in account both social and structural perspectives, as well as data access, becomes increasingly important as educational institutions strive to meet the challenges of accountability through improved decision-making practices. With such an understanding, educational institutions will be better positioned to explore possibilities of institution-wide, deep-rooted changes that pay heed to the factors that cultivate a culture of inquiry, in addition to improving access to data through more sophisticated information technology.

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