Activity-based Knowledge Management Tool Design for Educators

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ABSTRACT

Traditionally, knowledge management tool design has fit into the repository paradigm: a database of stored information that can be queried by an individual seeking information. These tools often rely on two distinct user groups: those who produce the knowledge and those who seek it. The disparity between these two groups – one group benefiting from the other group's work – is a leading cause of a knowledge management tool's failure. Additionally, knowledge management tools fail because the work processes of target users are not fully understood and therefore not addressed in the tool design [1].

Developing knowledge management tools for educators presents additional obstacles in this already hazardous environment. The traditional impediments found in the development of knowledge management systems, such as trust and incentive concerns, are present along with additional concerns faced by educators such as strict time and resource constraints. And like teaching, educators have different impressions of how knowledge management practices should be done. Therefore, any knowledge management tool for educators must address these obstacles in order to be effective.

This research describes the development of an *activity-centric* knowledge management tool. Activity-centric knowledge management tools avoid the repository paradigm by focusing on the processes in which work is done rather than the storing of information that results from such work. This approach to knowledge management in an educational environment allows teachers to focus on the work involved in teaching rather than knowledge management itself which typically involves added tasks such as entering information into a database. First, I describe current knowledge management practices of teachers by reviewing literature from education and knowledge management as well as interviews and surveys of teachers regarding how they incorporate knowledge management into their teaching practices. Next, I examine the development of the Survey Data Visualization Tool, an activity-based knowledge management tool. Finally, I analyze the use of the Survey Data Visualization Tool by a group of teachers.

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List of Abbreviations and Technologies

Ajax – Asynchronous JavaScript and XML
CSS – Cascading Style Sheets
GD – Graphics Library developed by Thomas Boutell, et al, used in PHP for dynamic generation of images
HTML – Hypertext Markup Language
MySQL – Open-source structured query language (SQL) database management system
PHP – PHP: Hypertext Pre-processor (recursive acronym)
LAN – Local Area Network
WAN – Wide Area Network

1 Introduction

1.1 Problem Statement

The majority of computer-based knowledge management tools, which typically come in the form of information repositories – interfaces that provide access to databases that store "corporate memories" – have proven to be largely unsuccessful [2]. These tools often fail due to three primary reasons: disparity between user groups, a misunderstanding of work practices while designing the tools, and the inability to learn from mistakes when a tool is poorly designed [1].

The information repository design paradigm is especially inappropriate as a means for sharing knowledge among educators. Along with the issues described above, an information repository does not address the unique restraints imposed upon educators due to the nature of their occupation, forcing teachers to add more work to an already overloaded schedule if they wish to use such a tool.

It is easy to overlook the true beneficiaries of knowledge management in education – the students – since implementing effective knowledge management tools in schools relies heavily on positive teacher outcomes. It is important to stress to teachers that by participating in knowledge management activities and using knowledge management tools, teachers have the potential to improve both the curriculum and their effectiveness as educators, which ultimately benefits the students.

This research describes a way of thinking about the design of knowledge management tools for educators in a fashion that differs from typical knowledge management tool design. Specifically, researchers can design knowledge management tools that are a*ctivity-centric*, meaning teachers can use the tool to do something they find productive while the tool still retains the ability to store and share information. Furthermore, researchers can design these tools without end results in mind, thus providing the teachers with the means to do something without dictating how exactly that "something" is done.

The development and subsequent use of the Survey Data Visualization Tool is one such tool and is described in this thesis. The tool was initially developed to help researchers visualize survey data generated by teachers. The tool was then redesigned as an activity-centric knowledge management tool, allowing both teachers and researchers to visualize and comment on the survey data. I used the tool in the following three ways: First, I queried teachers on their opinions of the results of surveys given to teachers regarding their collaborative habits. Second, I gave a survey to these teachers regarding their impressions of the tool itself. Third, I instructed the teachers to use the tool as they had in the initial phase of the research to view the results of the survey they took in the second step. Since the tool provides the means to perform an activity without dictating what that activity is or its results, these are not the only uses the tool is capable of. Another researcher might use the tool to simply collect data. A teacher might use the tool

to administer classroom quizzes or gather interest in participating in an after-school program.

1.2 Document Overview

In Chapter 2, I discuss the landscape of knowledge management for teachers. This section covers past research studying implemented knowledge management practices in educational environments. Also, I discuss the TeacherBridge project, a knowledge management tool designed for the sharing of best practices among educators.

In Chapter 3, I describe the process in which the Survey Data Visualization Tool was conceived, designed, redesigned, and deployed. I also discuss the methods I used to encourage teachers to use the tool.

In Chapter 4, I discuss how teachers used the Survey Data Visualization tool. This covers both the comments posted in response to visualizations and the results of the feedback survey given to the teachers who used the tool.

In Chapter 5, I reexamine the knowledge management landscape in education in the context of this research. I also examine the successes and failures of the Survey Data Visualization Tool and present possible avenues for future work.

2 Related Work

"Information is not knowledge."
Albert Einstein

Knowledge management is still a nascent organizational practice, so as of yet there is no agreed upon definition for it. Therefore, it is generally described as broadly as possible, such as the following specified by Prusak: Knowledge management is "any process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it reside, to enhance learning and performance in organizations [3]." Thus, knowledge management systems are tools designed to facilitate knowledge management, whether they are physical items such as file cabinets containing project reports, computer programs that contain employee meeting schedules, or training sessions used to verbally share work practices.

Knowledge does not simply "exist" – it begins as raw facts and numbers. When put into context, this data becomes information, such as the content of documents or records in a database. This information becomes knowledge only after it is combined with experience and knowledge [4].

It is important to keep this process in mind when developing knowledge management tools because simply storing information in the hopes that someone will act upon it is not always an effective method of disseminating information. Knowledge management tools should help the user to gather appropriate information when it is needed rather than require the user to hunt through data in an attempt to identify something salient.

As with knowledge management, the definition of collaboration will vary depending on who is asked to provide the definition [5]. For this research, I interpret collaboration as any exchange of information, either explicitly or implicitly, between two people, among a group of individuals, or even within a person's own mind. Collaboration can occur in one of the following four temporal/locality dualities: same time, same place; same time, different place; different time, same place; different time, different place. These classifications can be further complicated when incorporating them into Computer Supported Cooperative Work (CSCW) applications by expanding the definition of *place* to denote either a *physical place*, as in, a place in the "real world", or a *virtual place*, existing on a computer somewhere in "cyberspace". Regardless of duality, there must be *some* form of collaboration present in order for knowledge management to occur.

The goal of knowledge management in the workplace is to allow businesses to improve how knowledge within a company is used and shared [6]. Schools are in the business of knowledge, so it seems that schools would benefit immensely from participating in knowledge management activities. At the Knowledge Management in Education Summit in 2002, the participants agreed that knowledge management practices provide important benefits for educators, including better work processes, improved curriculum, and above all else, positive student outcomes [6].

Even though knowledge management practices can yield very tangible benefits, implementing them in a school can be problematic. Educators want to share with and learn from their coworkers, but they have been socialized into thinking that their actions in the workplace must produce easily identifiable outcomes. Thus, any activity outside of "getting the job done" that does not produce direct results is considered a luxury. This viewpoint leads to the following paradox: while schools are largely responsible for developing society's knowledge base, schools themselves have problems managing their *own* knowledge effectively [7].

Throughout the course of this research, I met with several teachers in order to better understand their collaborative behaviors, practices, and experiences. The details of each teacher and my relationship with them are described in Section 7.2 of the Appendix. Many themes were common among all of the teachers: lack of time, lack of encouragement, lack of incentives, and interpersonal conflicts often obstructed participation in knowledge management activities. With these concerns in mind, researchers should ask a simple question: Why *should* teachers participate in knowledge management activities? According to one teacher I interviewed, some should not. "I do what works in my classroom," he stated. "I'm not against it, but [collaborating with other teachers] hasn't worked [for me]." He cited that the process of working with other teachers is not easy and that often the "process gets in the way" [8].

An elementary school teacher I met with shared a story with me regarding her experience having another teacher work alongside her in her classroom. Pam is a first grade teacher. As a reward, Pam awards "fries" to students based on their positive behavior, manners, and work habits [9].

Fries are displayed on the wall in a spot visible from any location in the room. At the end of the week, students can redeem these "fries" for a number of items such as stickers, lunch with Pam, and books, among other items. This is an established practice that began at the beginning of the school year and is exclusive to Pam's classroom, though other teachers reward their students using different methods [10].

At the time of the incident Pam described to me, she had an 'inclusion' classroom, a standard class with some special education students present. Thus, she also had a special education specialist assisting her for approximately half the day [10].

One day while taking a test, the specialist took the special needs student to a separate location to better help them complete the test. When these students completed the test, the specialist rewarded them via her own reward method, by handing out multiple stickers and pieces of candy to each student. She did this without first consulting Pam [10].

The students who were working with the specialist came back into the classroom, proudly displaying their rewards. Naturally, the other students were quite jealous. This scenario immediately caused a problem with Pam, especially since Pam had informed the specialist of the established reward method of handing out fries [10].

Pam did not know how to handle the situation: the specialist was much older and had many more years teaching experience, thus Pam was initially nervous to discuss this matter with the specialist. Unsure of what to do, Pam consulted with a few of her coworkers face-to-face, as opposed to via email or the phone, who encouraged her to speak to the specialist directly. Pam did, but the resulting situation was far from ideal [10].

Pam attempted to talk to the specialist face-to-face regarding the situation in a positive manner, stressing that she wished her to abide by the procedures Pam had established for the classroom. This conversation was not well received by the specialist, and she acted "coldly" towards Pam. Pam then sent an email to the specialist, thanking her for her work in the classroom but did not receive a reply from the specialist [10].

No further discussion between Pam and the specialist took place. The specialist never rewarded the students in the classroom from that point on, and eventually the working relationship between Pam and the specialist returned to normal [10].

This scenario is an example where information sharing arises due to a specific need, i.e., a conflict between two teachers. Since there were no specific procedures governing the resolution of teacher conflicts to follow, Pam relied on her social network at her school and a friend in her social circle to acquire information on how to best handle the conflict [10].

Effective information sharing is important in the proper dissemination of school policies. During one school visit, I was discussing their knowledge management practices when a "Code Blue" event was announced. In the event of an intruder on the school grounds, the school enters Code Blue status, where it goes into lockdown. Code Blue drills give the school the opportunity to practice its lockdown procedures. Everyone in the school, from the administration down to the students, are aware of the procedure, though it was readily evident that exactly how the drill was to be performed was not uniformly known. First, the school principal announced over the loudspeaker that one of the teachers needed her "blue balls" returned to her. The teachers explained to me that any reference to a blue object over the loudspeaker alerted them that a Code Blue drill had just been initiated [11]. One teacher closed the door to the room we were in and turned off the lights. The two teachers then began talking about what they were supposed to do next. There was confusion between them – were they allowed to talk? Were they supposed to sit on the floor, out of sight from the doorway? When was the drill over? Eventually, one teacher opened the door to the room, walked outside and asked, "Is it over?" Had this been a true Code Blue event rather than a drill, walking out of the room and asking "Is it over?" could have had disastrous results. A critical school-wide policy such as a "Code Blue" event (or some other similar policy) is an example where effective knowledge management procedures could benefit those involved.

To help implement knowledge management practices, educational institutions are actively seeking technological solutions [6]. Technology often enables solutions to

problems, but it is not a panacea for all hindrances to collaboration, which is crucial in enabling effective knowledge management. It should not be expected that teachers who are given access to email will immediately and consistently begin to communicate with other teachers as a result. Proper education and organization is required to use technology effectively, and the field of education is no exception. Schools should reorganize themselves in order to implement technology properly, otherwise any possible impact the technology provides will not be fully leveraged [12].

Of particular interest is how technology affects educator interaction. Currently educators are faced with a high level of isolation within their classrooms. Computers on Local Area Networks (LANs) allow teachers to communicate with coworkers asynchronously, providing the ability to collaborate when convenient for all parties involved. Furthermore, Wide Area Networks (WANs) provide the opportunity for educators from different schools to collaborate with one another. It is important to note, though, that collaboration among educators is not guaranteed upon the establishment of LANs and WANs. These technologies must be implemented as part of an intricate social organization in order to maximize their benefits [12].

Along with providing an appropriate technological infrastructure, an equally appropriate organizational approach should be established when implementing collaborative practices in schools. One such approach is implementing team-teaching in the classrooms with educators who are predisposed to collaborating with their coworkers. Additionally, these teaching teams are supported by administrators who are in constant communication and occasionally lend classroom support.

Another organizational approach is to subdivide the classrooms into "neighborhoods": Each neighborhood contains classrooms physically near each other, with students subdivided into classes that typically travel together from classroom to classroom together [13]. This method allows teachers within the same neighborhood to share pertinent data about the students with each other easily since the classrooms are physically close. These neighborhoods are essentially small communities of practice [7].

Teachers are eager to use innovations that allow them to better collaborate with one another, but often the hindrances found in schools, those of time and place, prevent these educators from fully achieving their vision of collaboration. "The bell tells teachers when (and where) they can teach, communicate with other teachers, approach the counselor or principal with a problem and use the rest room [13]."

An institution-wide implementation of knowledge management practices, regardless of which approach chosen, can improve the sharing of information in a school exponentially [4].

Given the above definition of knowledge management, CSCW tools can be viewed as a specific type of knowledge management tools. Therefore, researchers should look to the problems that have been observed within CSCW tools and use them as guidance when developing knowledge management tools.

According to Grudin, there are three common problems that affect CSCW applications [1]. First, there is a conflict that exists among users of CSCW applications. These users generally fall into two distinct groups: information producers and information users. The producers create the information and store it in the application while the users retrieve and use this information. Conflict between these groups arises because the producers receive no benefit from using the application. The work they do with the application allows others to do their jobs but does not help them do their own jobs, thus causing the producers to ask themselves, "How is using this tool helping *me*?" Without the producers, though, the consumers would have no information to retrieve, rendering the tool useless to both groups.

The second problem with CSCW tools occurs when all target users of the tool are not satisfied with the application [1]. Similarly, Hasan and Gould reports that knowledge management tools' failure is most often caused by a misunderstanding of work practices [2]. In CSCW tools for educators, this misunderstanding stems both from application developers and the teachers. For example, teachers often participate in information sharing without realizing it, thus making it problematic to ask teachers how they share information with coworkers since they do not realize that they *are* sharing. One teacher I spoke with explained how the attendance system worked at her school. During homeroom, teachers take attendance using a computer-based system. The teachers check the attendance system throughout the day, comparing the attendance of their class to the attendance recorded in the system. Any discrepancies between the two are noted and reported [14].

It was clear that the teacher describing the attendance system relied on the knowledge it contained, but did not think of the attendance system as an information sharing device, even though the information contained in the system was generated by her peers. The inability to describe information sharing and collaborative working relationships is due in part to the educator culture not having a *lingua franca* for this purpose [6].

The final problem common to CSCW applications lies with the application developers. Despite the majority of these applications failing, researchers continue to create similar applications, perpetuating the cycle of failure [1].

Thus, researchers need to address these problems if we are to design successful knowledge management tools for educators. This research addresses these problems in reverse. I acknowledge the third problem by realizing that past designs were often ineffective and must take a different approach in order to be successful in future tool design endeavors.

Before any system design begins, researchers should first thoroughly understand the existing work practices of the educators. Any tool designed for teachers should make their jobs easier, thus it is imperative that researchers understand how teachers do their work before we develop anything for them.

In an educational environment, part of understanding work practices involves understanding the social landscape. An effective knowledge management tool designed for educators will attempt to address problems (where appropriate) within the social structure.

Researchers can avoid Grudin's second problem by engaging teachers in participatory design. Partially yielding design control to the users gives us a much better chance of developing a valuable application that addresses their needs as the teachers themselves will be dictating what the tool does. This helps researchers avoid the common trap of developing "technological solutions looking for a problem".

This research proposes a design paradigm for educational knowledge management tools that seeks to meet these requirements. Tools designed using this paradigm have two identifying characteristics that differentiate them from previously designed knowledge management tools. First, these tools are *activity-based*, that is, they give the teacher the ability to *do something* rather than just enter information into a database. Second, these tools do not dictate the outcome of these activities: they provide the "building blocks" to perform a task without specifying how these blocks should be "put together". These two characteristics, coupled with the ability to retain and report information gathered during tool use, are the key components to an activity-centric knowledge management tool. For instance, the attendance system described above can be modified into an activity-centric knowledge management tool by incorporating means that allow teachers to record notes regarding student behavior which can then be viewed by other teachers who have those students in their class. Consider this scenario: During homeroom, Howard and Jeffrey get into an argument and a small scuffle. The homeroom teacher, after disciplining the students, records the information about the fight in the attendance tool. Ms. Stabilo, Howard and Jeffrey's fourth period Math teacher, sees this note and makes sure to keep the two students separated during class to help avoid another confrontation.

This activity-centric design paradigm emerged from TeacherBridge, a collection of CSCW tools developed to encourage collaboration among teachers by establishing an infrastructure that supports both social and technological needs [15]. From the outset of the project, TeacherBridge participants were encouraged to collaborate and share with each other, using TeacherBridge's tools to facilitate these activities. We found, however, that teachers were not able to connect how these tools could be used to accomplish our goals of sharing [16].

What we did find, however, was that teachers were using information captured in other teachers' work and reusing this information in their own work. For example, a web site designed to communicate with students' parents was scaled to serve as the entire school's web site [16].

Tools, regardless of their application, are imbued with knowledge [17]. Tools are designed to accomplish a task, and therefore the knowledge required to accomplish this task is captured within the tool through its design, such as the optimum handle length of a hammer [17]. Computer-based knowledge management tools carry this idea further in

that they contain both implicit and explicit knowledge. Implicit knowledge is imbued within the tool by anyone who helped design the tool, while explicit knowledge is stored within the tool by the tool's users [17].

So while traditional knowledge management tools are designed to convey explicit knowledge, something *tangible* users can hold on to, tools such as TeacherBridge can transmit both explicit and implicit knowledge stored within the tool itself. The scaling-up of an existing website cited above is an example of this type of information sharing. The tool user did not access TeacherBridge looking for instructions detailing how to design a website. Rather, they viewed a smaller site and based the larger design on the existing one.

This is not to say that the design paradigm presented in this research is the best design for knowledge management tools for teachers. Rather, the paradigm arose in our research by addressing Grudin's three problems and engaging the teachers in participatory design. There are circumstances where another design paradigm, such as an information repository or something altogether different, would be appropriate. If researchers are concerned with designing appropriate knowledge management tools for an existing domain, they should be cognizant of existing work practices and engage the target users in participatory design activities in order to be successful.

In this section, I presented an explanation of knowledge management, how collaboration ties in to knowledge management, and how schools can benefit from implementing knowledge management practices and tools. I also discussed how CSCW tools relate to knowledge management and how the majority of these tools have failed due to problems explained by Grudin [1], and Hasan and Gould, [2]. The benefits of knowledge management can be realized if these problems are addressed, and I have covered one such knowledge management tool, TeacherBridge, which accomplished this. Chapter 3 details the development of the Survey Data Visualization Tool, another knowledge management tool that addresses the needs of its users while providing a task-based activity as the means for information sharing.

3 Design Methodology

In this section I describe the process in which the Survey Data Visualization Tool was conceived, designed, redesigned, and deployed. I also discuss the methods I used to encourage teacher participation.

3.1 Tool Origins

Over the course of a year (2003 – 2004), TeacherBridge participants were asked to complete electronic surveys. Two different surveys were given three times each. The participants completed these surveys electronically via a web-based form.

The results of these surveys were stored in simple text files, one file each for every participant for every survey he/she took. After all six surveys were given, we were left with 115 different files to sort through. Since visualizations provide insight into data [18], I first created static visualizations using a spreadsheet. This effort resulted in very basic visualizations which were hardly useful since we had no way of easily filtering data, a key ingredient to the usefulness of information visualization [19]. In order to have better use of this data, we needed a tool which provided robust filtering mechanisms, e.g., the ability to view the survey results of only the Math and Science teachers for the third question of the first survey. We needed a visualization tool that could dynamically generate visualizations of the survey data, so I built the first version of the Survey Data Visualization Tool.

3.2 Survey Data Visualization Tool Design

3.2.1 Tool Architecture

The Survey Data Visualization Tool is a web-based application which uses PHP, HTML, CSS, and JavaScript for its front-end and a MySQL database with MyISAM tables for data storage.

3.2.2 Initial Tool Design

Initially, the Survey Data Visualization Tool was a “traditional” form-based web application which required navigating through multiple pages in order to generate one set of visualizations. First, the user chose one survey from the list of available surveys in the system, as seen in Figure 1.

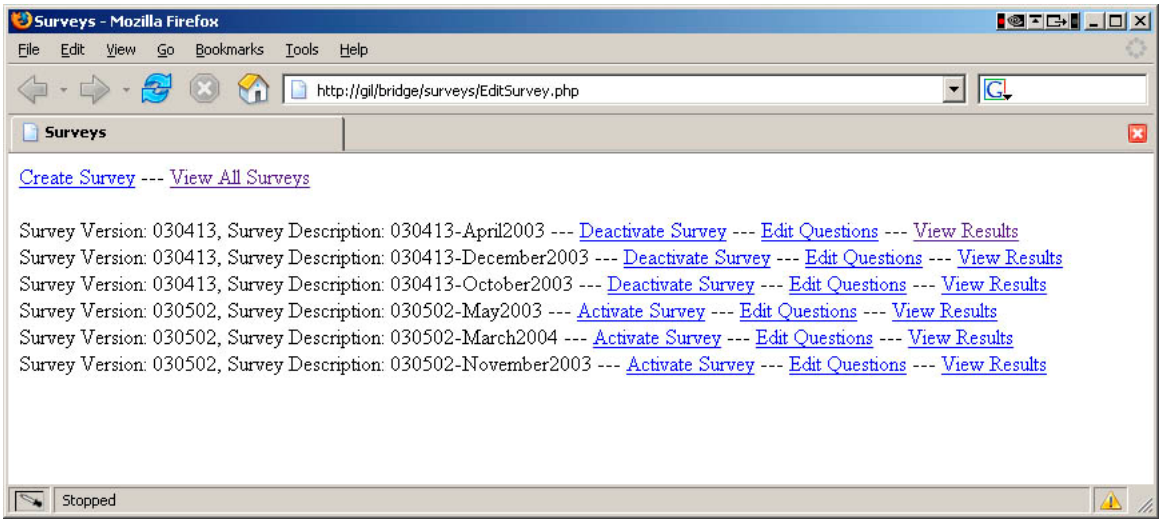


Figure 1: Survey list, original Survey Data Visualization Tool design

Next, the user needed to select a visualization type for the data along with the questions that were to be visualized, as shown in Figure 2.

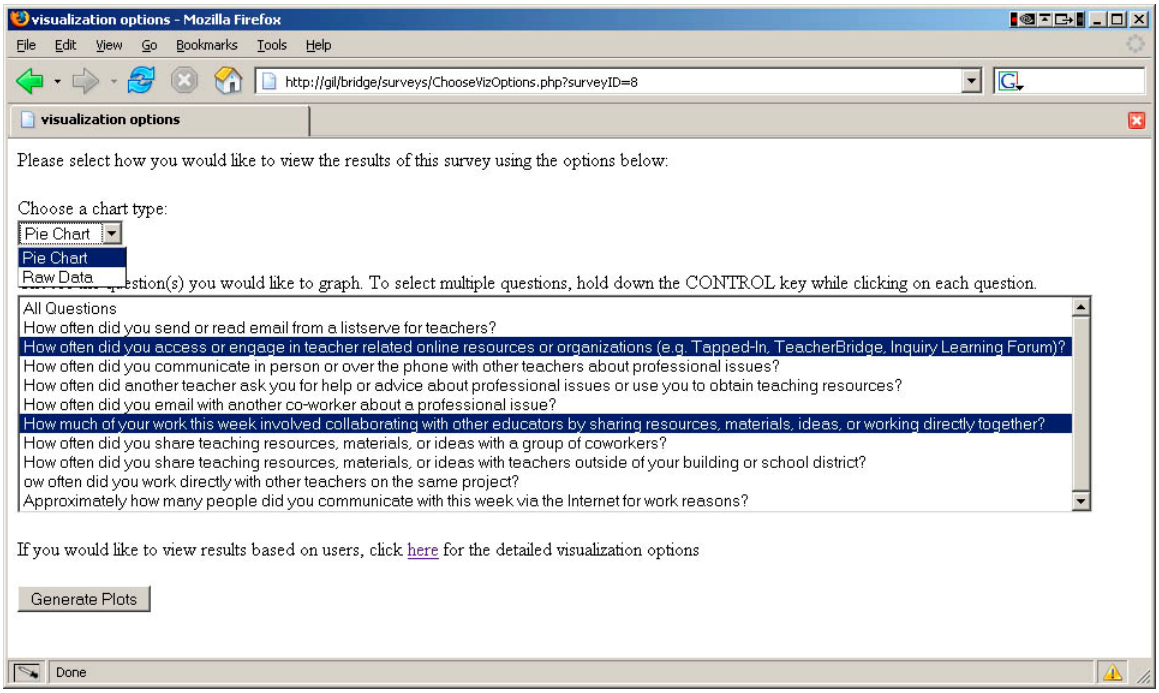


Figure 2: Visualization generation, original Survey Data Visualization Tool design

Finally, the visualizations for the selected questions of the chosen survey were displayed in a single column, as seen in Figure 3.

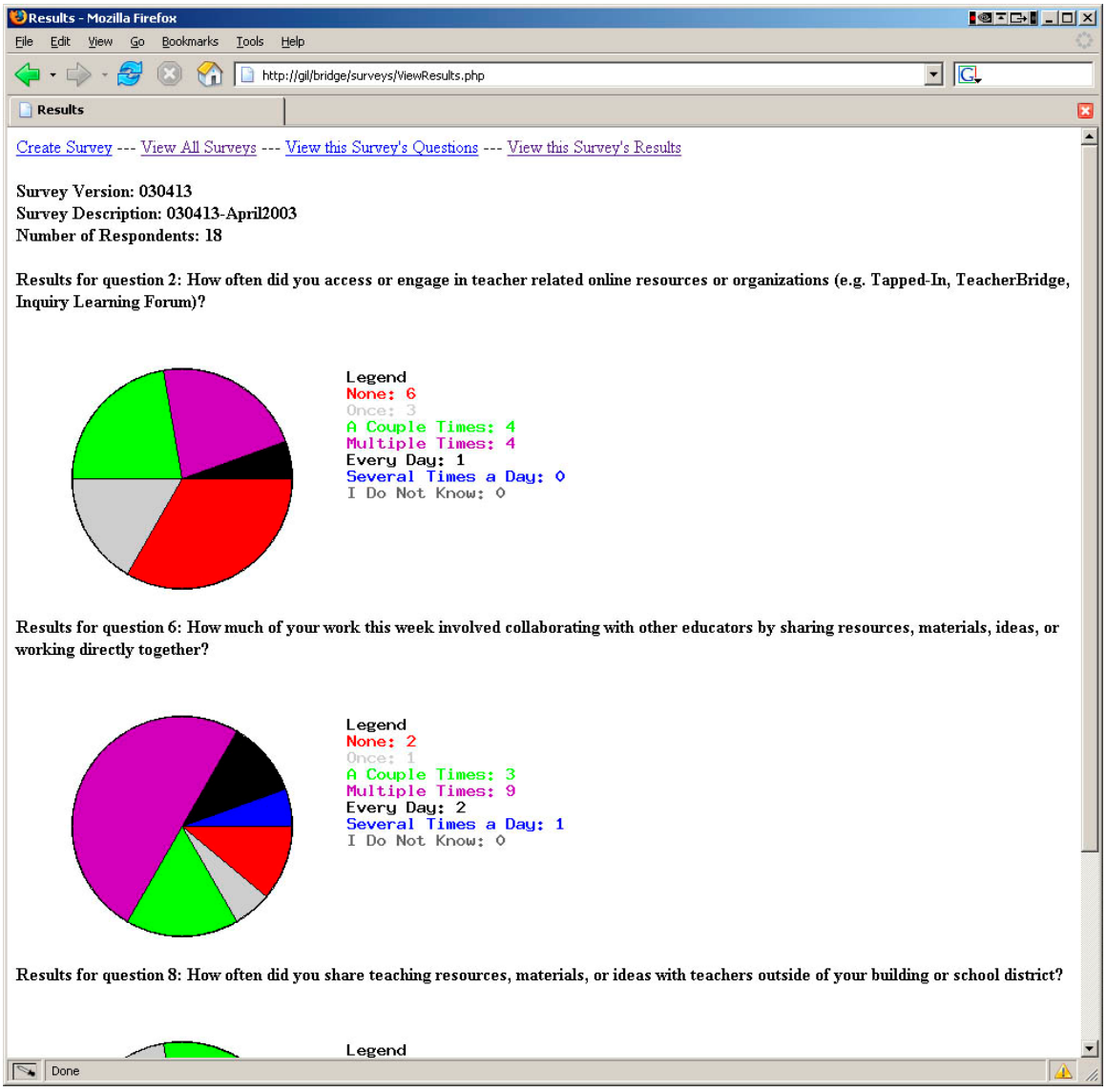


Figure 3 - Completed survey visualization, original Survey Data Visualization Tool design

Although it provided useful information to researchers, this design was lacking in a three ways. First, generating a set of visualizations felt too cumbersome since the process spanned multiple pages. Second, only visualizations for one survey could be displayed at a time, so it was impossible to see changes in answers over time. Last, changes to visualizations could not be made easily. If a user wanted to change the parameters of a visualization, they would have to start the visualization generation process from the beginning.

Keeping these issues in mind, I sought to redesign the tool via hill climbing, a design method which addresses issues from preexisting tools in order to develop better subsequent tools. [20]. In order to meet the above guidelines, I needed to use a different approach to designing the application since a traditional form-based application would not be able to achieve my design goals.

The second version of the Survey Data Visualization Tool was designed using an approach to web application development that is now being referred to as the Ajax framework [21]. Applications designed using the Ajax framework are dynamic web-based applications which generally use the following components:

- HTML and CSS for mark up and visual appearance
- JavaScript for dynamically modifying the content of a web page
- The XMLHttpRequest object for asynchronously sending and retrieving data to and from the web server

The above components are usually used in conjunction with a server-side scripting language such as PHP or ASP to provide an increased level of interactivity [21]. Application data is stored in a MySQL database and retrieved using PHP.

By using PHP in conjunction with the Ajax framework, I was able to meet my initial design requirements. First, every piece of information required to generate a visualization was accessible on one page. Second, the updated version of the tool grouped similar surveys to allow the results of multiple surveys to be viewed. Third, if a user needed to make a slight change to the visualization parameters, e.g., change the visualization type, it required only the amount of time to select the proper option. All of this was achieved on a single page that did not require a page reload or refresh when displaying data.

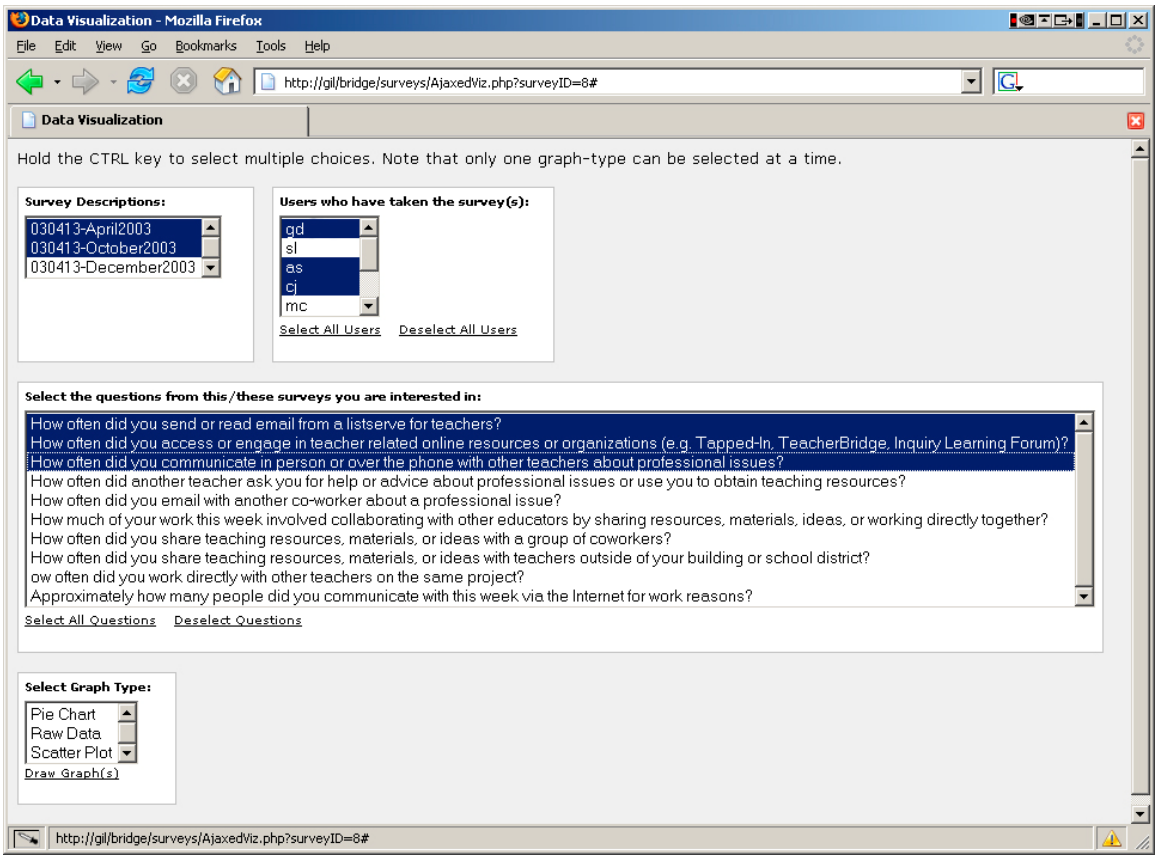


Figure 4 - The updated Survey Data Visualization Tool, designed for researcher use

The updated Survey Data Visualization Tool consisted of similar parts as the original tool, but the order in which options were chosen to generate a visualization were changed.

Each survey given has a version number. Surveys with the same version number are structurally identical. They have the same questions with the same answers in the same order, but they were given to TeacherBridge users on different dates. The survey tool groups surveys based on their version number. The first step in creating a visualization was to choose which surveys the data is to be viewed from. Upon this selection, the system populated the user box with only the participants who took the survey selected. If multiple surveys were selected, only the users who took all of the selected surveys were displayed in the user box.

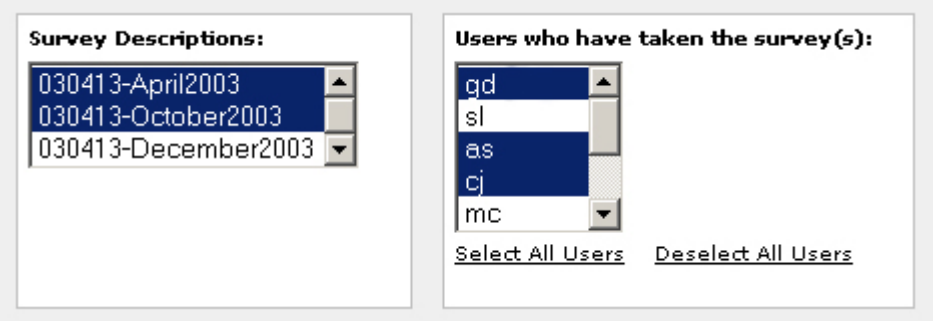


Figure 5 - Upon selecting a survey or surveys, the user box was populated with a list of users who took the selected survey(s)

The second step in creating a visualization was to select the desired participants from the user box. Links were included to either select or deselect all users. These functional affordances [22] allowed tool users to accomplish a common task quickly.

Next, the tool user chose the questions they wanted to see the results of. One, some, or all of the questions from the surveys could be chosen for visualization.

The final step in creating a visualization was to select the visualization type. The two visualization types that were always available were pie charts and raw data tables. If more than one survey was selected, scatter plots were also available as a visualization type.

When the above steps were completed, the tool user clicked the button-styled link labeled "Show Visualization(s)" (see Figure 15) to generate the visualizations. If any one of the steps was not completed, the tool would generate a JavaScript alert informing the user of the step or steps they skipped.

Multiple representations can increase user understanding of data [18], so the tool was designed to provide three visualization types: pie charts and raw data tables were always available to the user, and scatter plots were available if the user selected more than one survey.

The pie chart visualization drew a complete pie chart, assigning the appropriate percentage of the pie to each answer based on the number of respondents who chose that answer for a given survey. The visualization also rendered a textual legend which contained the answers available for the given survey question. The answer's pie slice and the answer text in the legend were given a matching color distinctive from the other answers' colors.

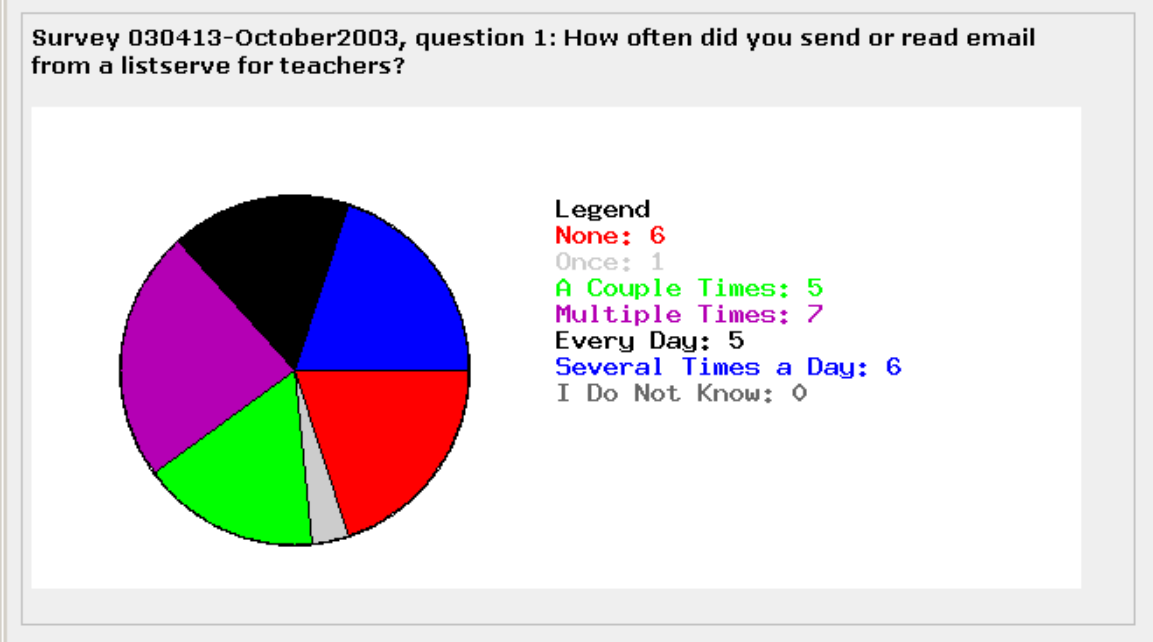
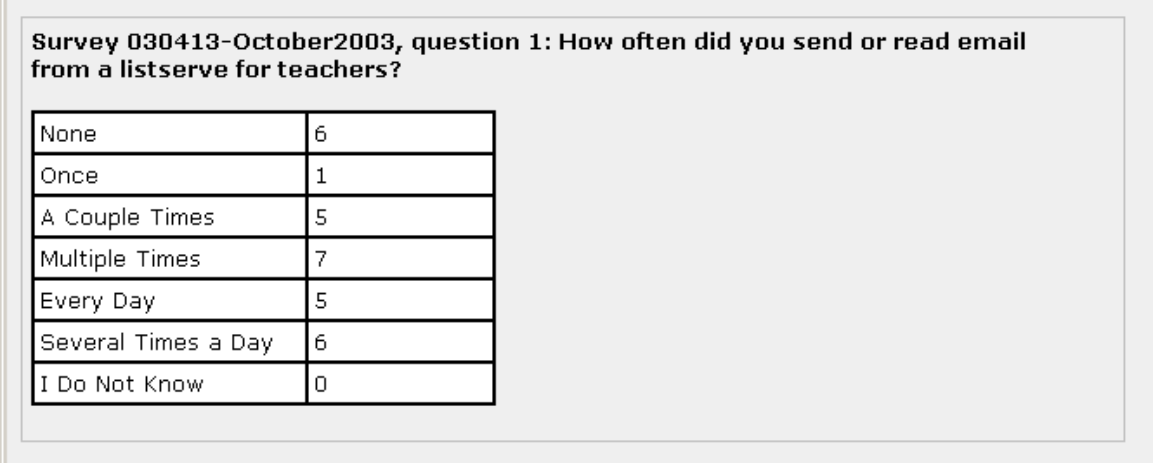


Figure 6 - Original pie chart visualization

The raw data table visualization rendered a two-column table containing the answers in one column and the corresponding number of recipients who chose that answer in the adjacent column.



Survey 030413-October2003, question 1: How often did you send or read email from a listserve for teachers?

None	6
Once	1
A Couple Times	5
Multiple Times	7
Every Day	5
Several Times a Day	6
I Do Not Know	0

Figure 7 - Original raw data table visualization

The scatter plot visualization allowed a researcher to view how a respondent answered a question over the course of the selected surveys. Each respondent selected for the visualization was displayed using a unique icon at each data point on the graph. Additionally, the scatter plot visualization provided a legend detailing which icon represented which user.

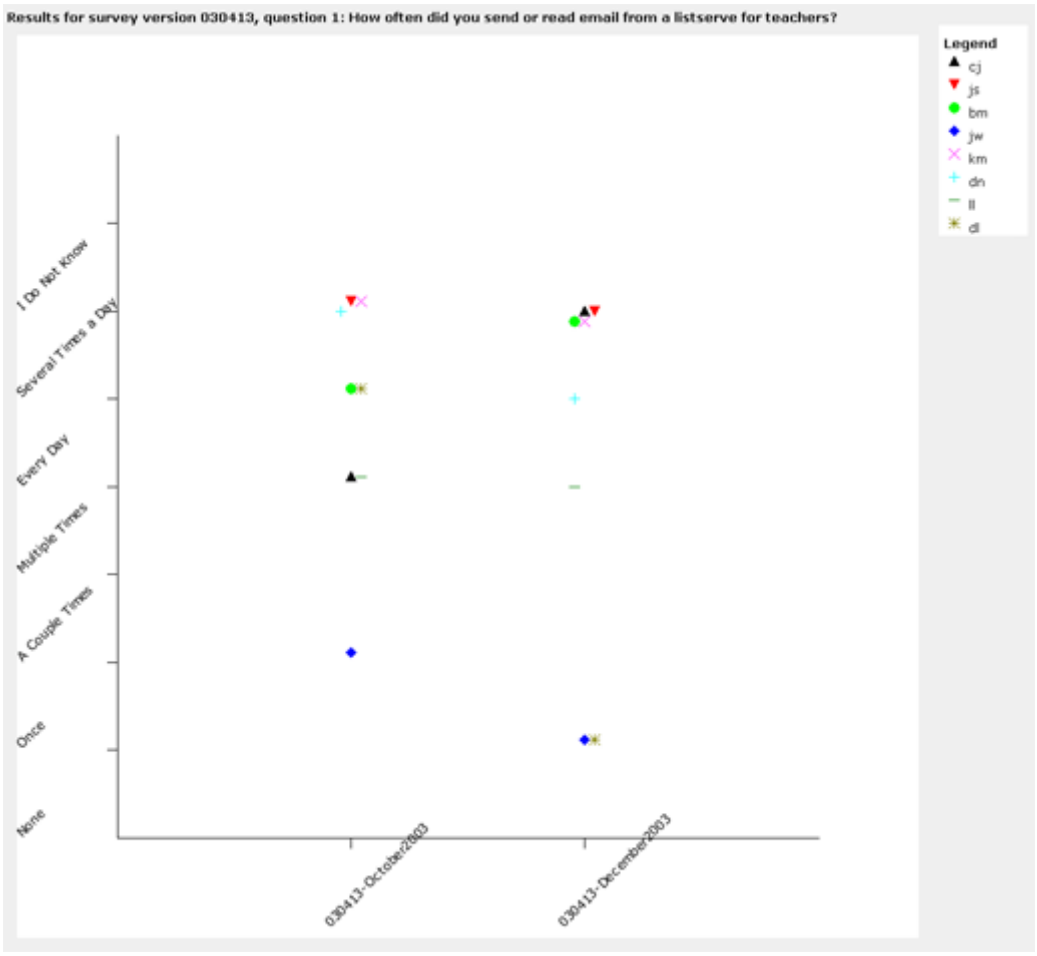


Figure 8 - Original scatter plot visualization

If a researcher chose more than one survey and specified either pie chart or raw data table visualizations, the resulting visualization sets for each survey were displayed in rows, one above the other. This layout allowed the researcher to view easily the differences in responses for a question from one survey to the next.

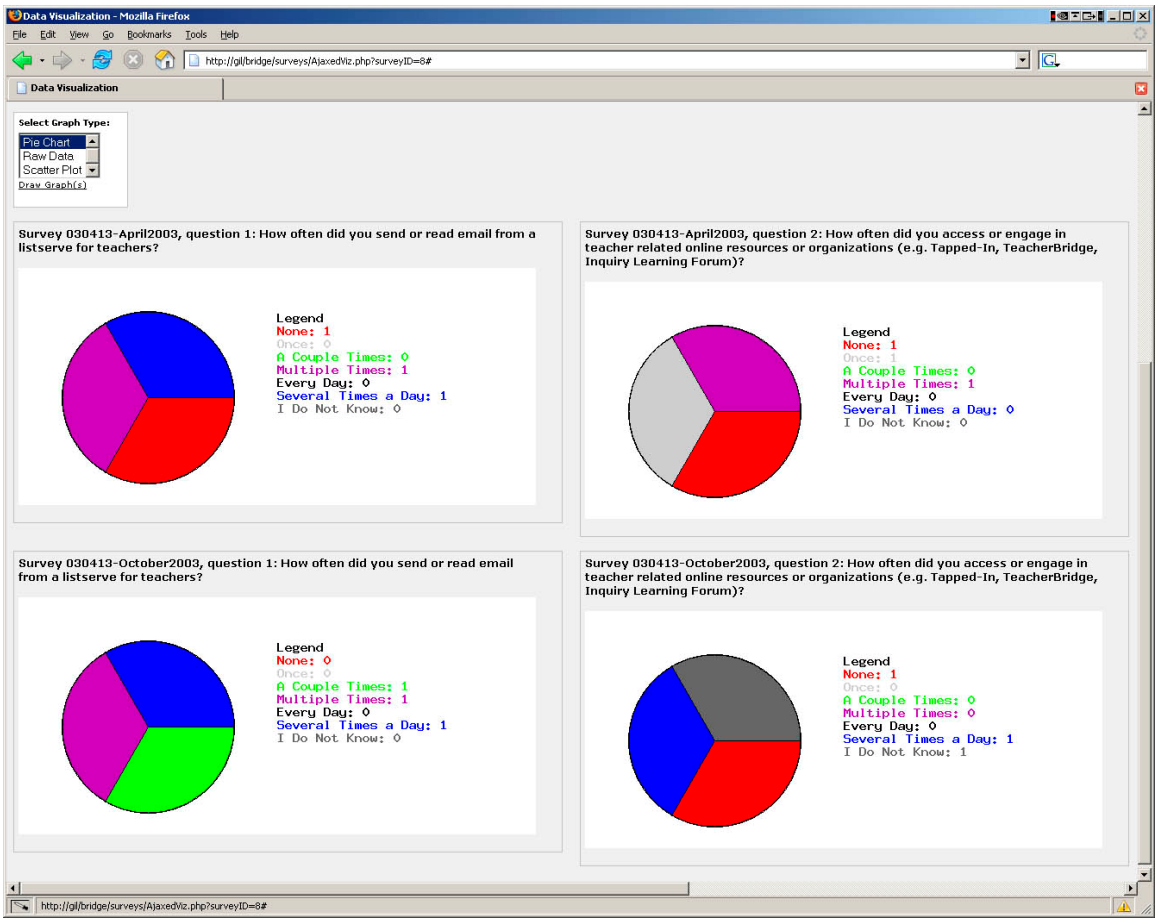


Figure 9 - Viewing results from multiple surveys

While the ability to generate visualizations dynamically was useful to us as researchers, we realized that if we exposed teachers to the Survey Data Visualization Tool, we would be presented with an opportunity to study what teachers do with and how they handle shared knowledge. I reasoned that I would have a better chance at getting teachers to use the tool if I made it an activity-centric knowledge management tool. The new tool would be focused on an activity and provide a means for seamless information capture and dissemination. Specifically, the updated tool would allow teachers to generate visualizations of the survey data while providing a mechanism for them to read and post comments regarding these visualizations.

3.2.3 Updated Design Rationale

The updated design of the Survey Data Visualization Tool began with the Visual Information-Seeking Mantra: *Overview first, zoom and filter, then details-on-demand* [19]. The previous design of the tool followed mostly this mantra, short of the initial overview. I added an initial page to the tool which displays a list of surveys and their respective questions that can be visualized using the tool.

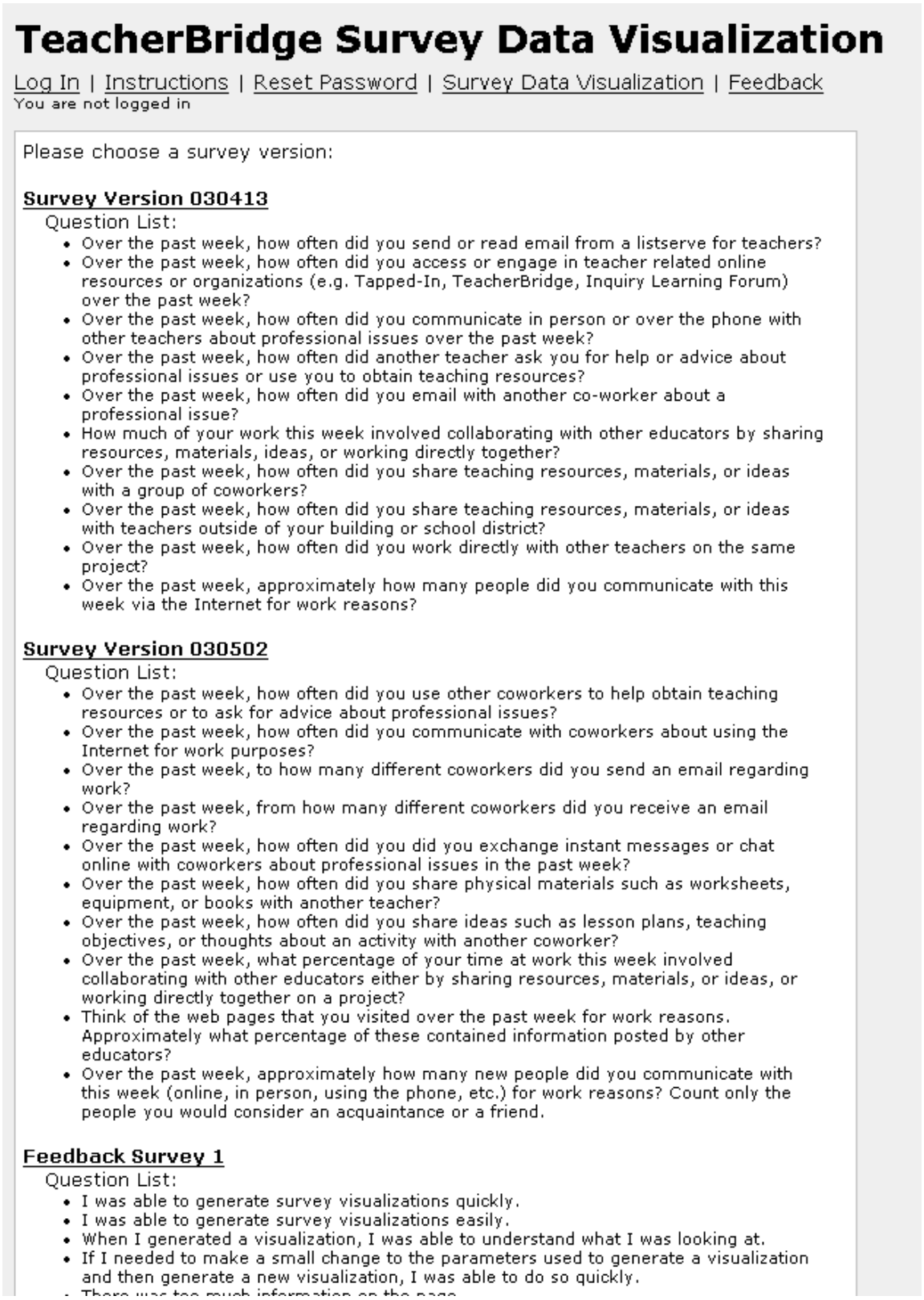


Figure 10 - Initial screen of Survey Data Visualization Tool listing the questions of the surveys that can be visualized

Without user participation, a knowledge management tool is just a tool with no information contained within it, essentially rendering it worthless. Therefore, when I redesigned the Survey Data Visualization Tool, each design decision made was an attempt to encourage and sustain teacher use of the tool.

To achieve this, the Survey Data Visualization Tool had to present information that carried meaning to the teachers. Otherwise, the chance of achieving any level of participation from teachers would be low. "If the questions on the survey don't directly apply to my teaching," wrote one teacher who participated minimally in the TeacherBridge project, "then [the results] aren't very important to me. [23]"

3.2.3.1 Encouraging Participation through Additional Query Options

As shown in Figure 11, participants who had taken a survey were displayed in the Survey Data Visualization Tool by the first half of their email address. This was acceptable for researchers, even preferable in some cases, and it would allow teachers using the tool to easily identify how their coworkers were responding to survey questions.

This may have increased teachers' use of the tool, but the privacy issues this feature raised outweighed any participation increase it may have been responsible for. The solution was to display an anonymous user ID rather than a user name.

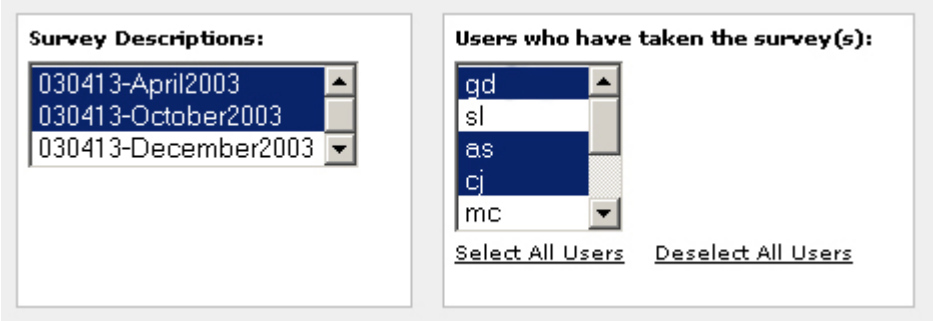


Figure 11 - Original survey box and user box

This design solved the privacy issue but raised a major concern that was not as obvious when the users were identifiable by their names: how would a teacher using the tool know who "User 10" is? And more importantly, why would a teacher *care* about "User 10"? I decided that they would not know and they probably would not care. Without a connection to the respondents, the teachers using the tool were unlikely to care about the data, which would subsequently reduce their interest in the tool and thus not participate.

In order to establish a connection, I reasoned, the teachers using the tool would need to know something about the respondents in order to form a connection while allowing the respondents to remain anonymous. Since the respondents were not anonymous in the database, I was able to associate the subject or subjects the respondents taught with their answers, thus making it possible to view survey results based on teacher types. As further motivation for providing this feature, Neale, et al, report that teachers were more

likely to use a web-based forum when they had the opportunity to comment on responses from users who belonged to a group different from their own [24]. The claims analysis table for this design decision is shown below:

Show survey respondents' names + Tool users can see easily how their peers responded to surveys – Displaying respondents' names creates privacy concerns Show an anonymous ID number instead of respondents' names + No privacy concerns – No way of knowing who a user is or what they do Display subjects taught for a given survey respondent + Establishes connection between tool user and survey respondent + Can provide meaning to otherwise anonymous data – Adds more information to page

Table 1 - Claims analysis for survey respondent display name design decision

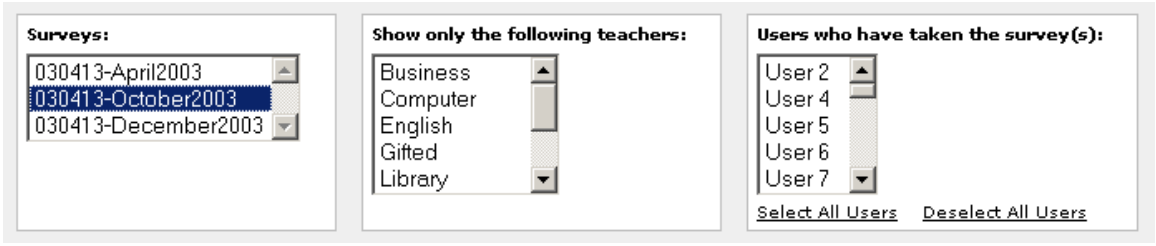


Figure 12 - The Survey Data Visualization Tool displays only the users and the subjects they teach for a selected survey

As seen in Figure 13, choosing Business and English teachers reduces the users displayed in the adjacent box to only those respondents who teach Business or English. Selecting respondents based on the subject(s) they teach is an optional step in the current version of the tool.

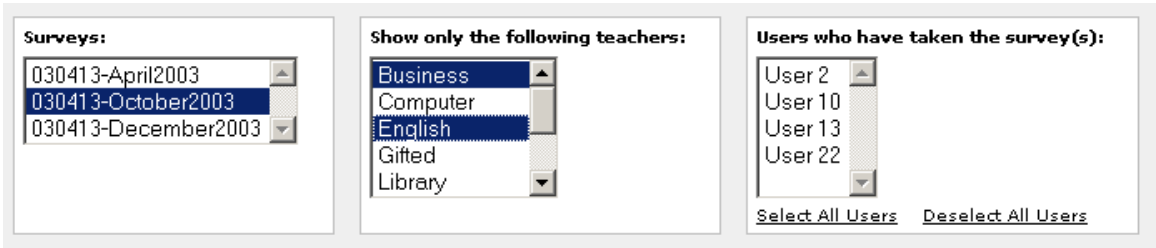


Figure 13 - Selecting specific subjects displays only those teachers who teach the selected subjects and took the selected survey

3.2.3.2 Carroll, et al Design Guidelines

In *Knowledge Management Support for Teachers*, Carroll, et al, present a list of areas where they believe research in teacher knowledge management should take place [7]. Three of these areas served as design guidelines:

Knowledge management tools for teachers should facilitate convenient knowledge capture: The Survey Data Visualization Tool needed a mechanism to allow teachers to contribute their knowledge to the system while requiring very little effort. This mechanism would have to be integrated into the tool in an area near the information that was being examined. I decided to add a comments section next to each visualization which is initially hidden but when clicked on, opens to display both existing comments and a text field for a comment to be added should the teacher wish to add a new comment. The positioning of each comment section makes it clear to which visualization the comments are pertaining.

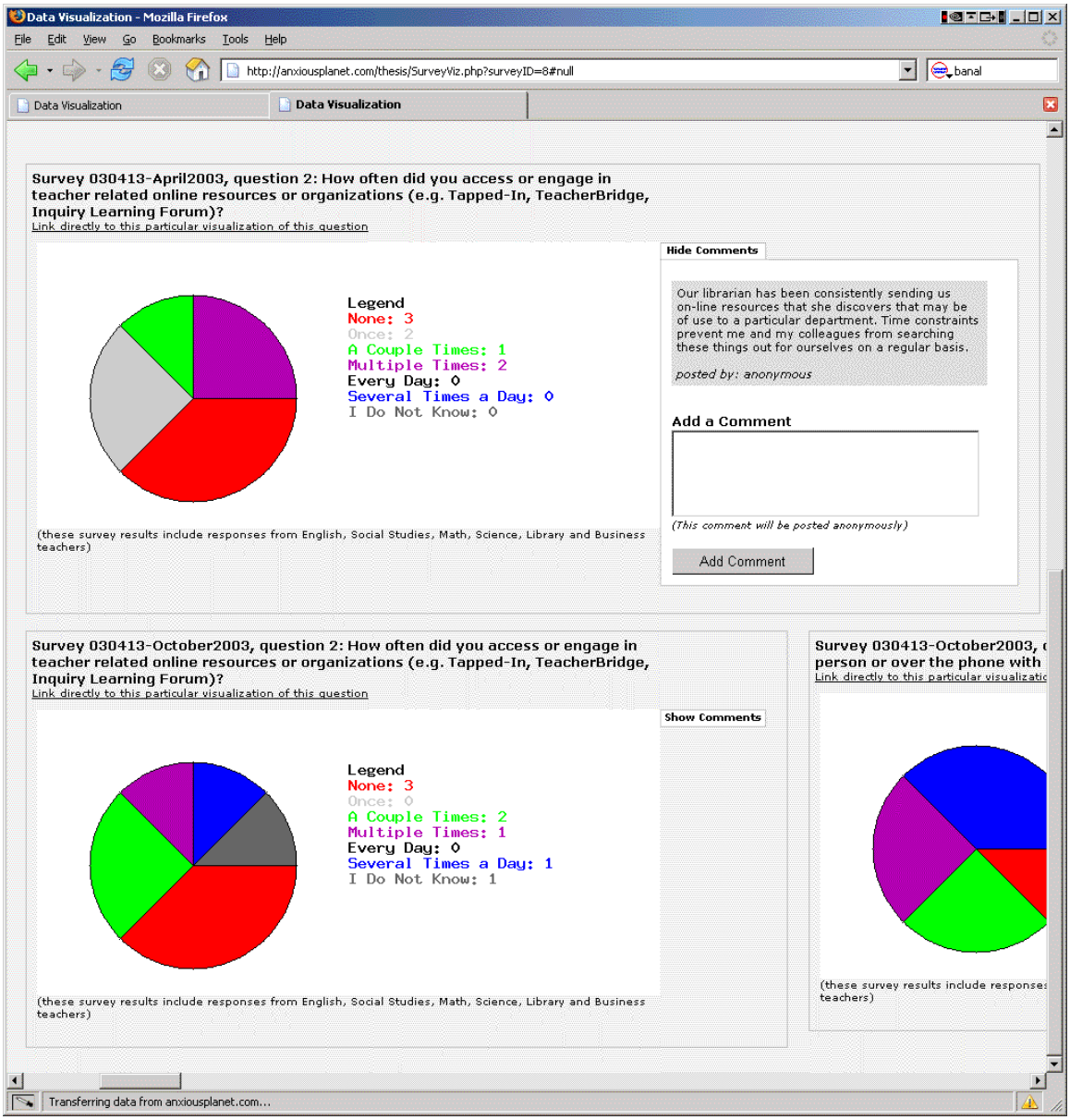


Figure 14 - Placing the comment section next to the visualization allows for convenient data capture

Shareable knowledge should be easily retrievable: The Survey Data Visualization Tool is web-based and uses either common web elements, e.g., select boxes and hyperlinks, or elements that look and behave like common web elements. For example, since the tool does not need to reload the page to display new data, a traditional "Submit" button is not used. Rather, a hyperlink that is styled to look like a button is used instead.

Figure 15 - Traditional button and a hyperlink styled to look like a button

To ensure a high level of accessibility, the tool remained as a lightweight, fast-loading web application rather than a Java applet or a stand-alone application. This low barrier-to-entry ensures that as long as a teacher has an Internet connection and a web browser, they can access the survey tool. This level of accessibility allows the knowledge stored in the tool's database to be easily retrievable.

Information should make sense so that it becomes shared knowledge: The survey results stored in the database are presented in a way such that no information displayed is ambiguous or confusing. The data can be visualized in three different ways: pie charts, raw data tables, and scatter plots.

The pie charts use a selection of dissimilar colors to ensure that the results of options are never confused with one another. Furthermore, each answer is written in a legible font using the same color used to denote the answer in the pie chart.

Each line of a raw data table contains each answer choice for a given question and the number of respondents who chose that answer. The simplicity of this visualization prevents any ambiguity as to how many respondents chose each answer.

Each data point on a scatter plot is rendered as a unique shape with a unique color. Additionally, there is no overlapping of the data points so the location of the data points will never be obscured from the users' vision.

Above each visualization is the question which the visualization pertains to. Beneath every visualization is a statement which explains which teachers' responses are displayed in the visualization. These two cognitive affordances [22] ensure that a teacher can always figure out at a glance which results they are viewing.

3.2.3.3 Encouraging Participation through User Profiles

I wanted to give users an opportunity to take ownership of the comments they posted if they chose to, so I implemented a user profile system to address this need. All users with accounts can specify a display name and an occupation. If a user is logged in and chooses to post non-anonymously, this display name is shown next to the comment. A user's occupation can be a researcher, administrator, or teacher. Teachers can specify which grades they teach, which subjects they teach, and which schools they teach at. Administrators can specify which schools they are associated with. Researchers have no additional options to modify aside from their display name.

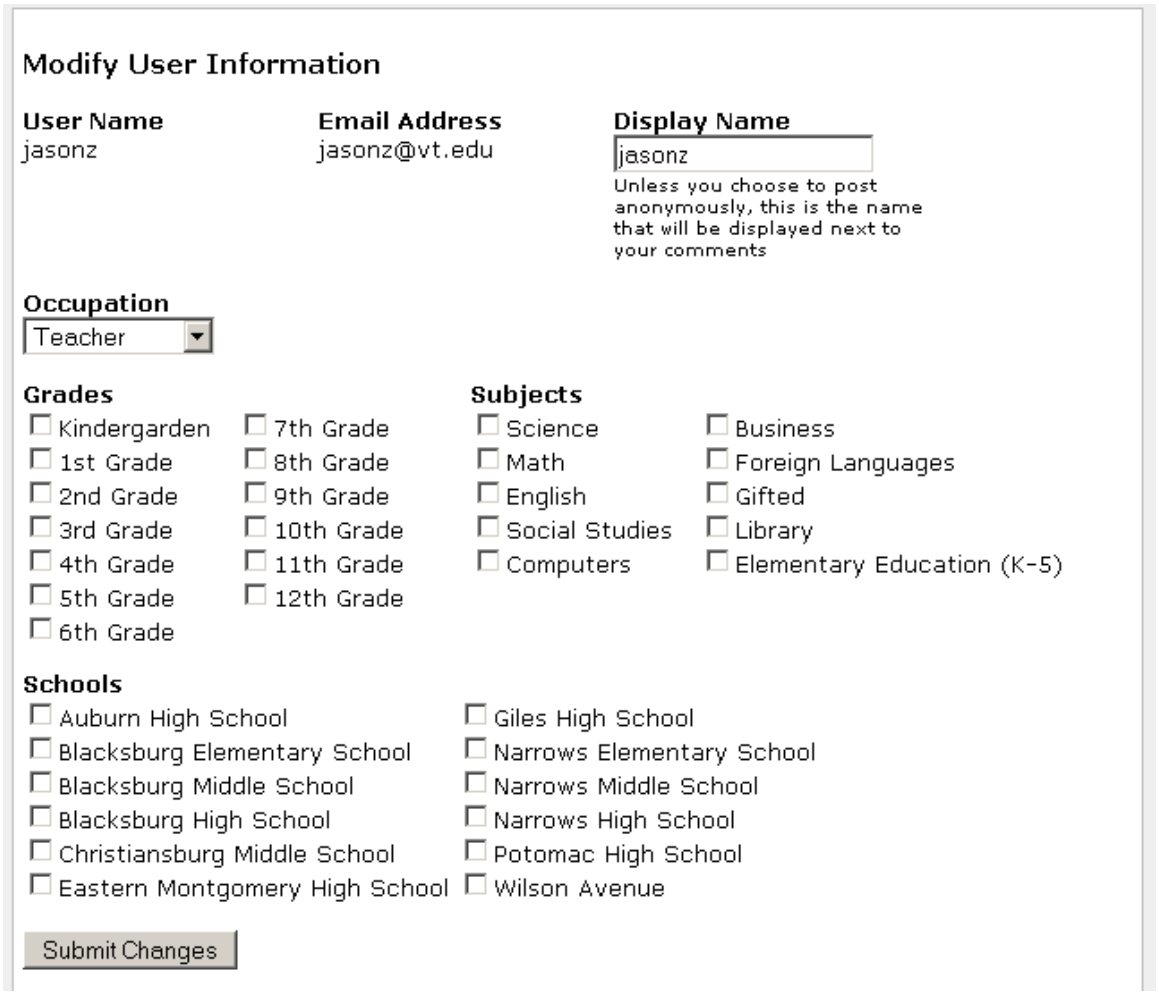


Figure 16 - User Profile Screen for a teacher. Administrators have only the *Schools* option. Researchers do not have any other options aside from *Display Name* and *Occupation*

Completing a user profile is entirely optional.

3.2.3.4 Comment System

When a comment is posted, all query parameters that were selected to generate the current visualization, along with the comment text, are entered into the MySQL database. These parameters include the surveys, user list, question list, and display type. Additionally, the question that the comment addresses is also stored in the database.

Initially, I had two options when deciding when to display comments. The first option was to display comments only when identical parameters were specified to generate a visualization. For instance, if a user generated a set of visualizations using survey 030413-April2003, User 10, and questions 1 and 2 as parameters and posted a comment regarding question 1, that comment would only be displayed when a visualization set is generated using identical query parameters.

The second option was simply to associate comments with questions. If a comment was posted for a question, that comment would be viewable as long as that question was specified in the survey parameters.

In the former design scenario, a comment would always pertain to the data it was being displayed next to, thus preventing any ambiguity that might arise upon subsequent viewing of the comment. Unfortunately, this design might also lead to "data burying", where comments posted are never seen by users other than the comment author because identical query parameters are never specified

The latter design idea removes the possibility of data burying, but brings with it the chance for ambiguity to be experienced by users who view the comment in a visualization set that differs from the set generated when the comment was originally written. Without proper context, a comment might not make sense.

Finding neither option wholly appropriate, I compromised: I decided always to display comments next to the question they were written in response to, regardless of query parameters, and I stored all of the query parameters used to generate the visualization along with the comment text and the user who posted the comment.

Associate comment with specific survey visualization + Comments would always have a strong correlation with the visualization displayed – Comments might get "buried" Associate comment with question it was written in response to, regardless of visualization parameters + Comments would be more visible – Comments might not make sense

Table 2 - Claims analysis for comment association design decision

When a user is logged in and posts a comment, by default, the user's display name is shown after the comment. Users who are logged in have the option to post a comment anonymously if they choose. Users who are not logged in can only post anonymous comments.

Figure 17 - Logged/Unlogged comment window

I theorized that teachers would be more likely to post comments if their participation did not require much more effort than the effort they were already putting forth, generating visualizations with the tool. A participant, regardless of the tool they are using, is more likely to use a tool if the tool is not difficult or frustrating to use.

The comments can also help researchers while they are giving a survey. Being able to post comments immediately after taking a survey allows the survey participants to share feedback regarding the survey questions while the questions are still fresh in the participants' minds. Comments allow researchers to learn how participants feel about the questions which can help direct the line of questioning the researchers pose in future surveys. Additionally, the comments allow participants to share their thoughts regarding the survey questions with other participants. An example of this is discussed in Section 4.3.

3.2.3.5 Encouraging Participation with Recent Comments List

Although associating comments with questions rather than specific query parameters increases comments' visibility, there was still no way to view a comment without generating a visualization first.

I wanted to implement functionality in the tool that would address both of these issues, so I added a hyperlink at the top of the Survey Data Visualization Tool page which, upon being clicked, revealed the five most recent comments that had been posted.

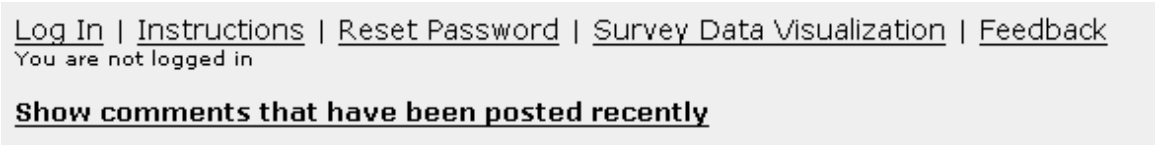


Figure 18 - Link at the top of the Survey Visualization page which displays recent comments

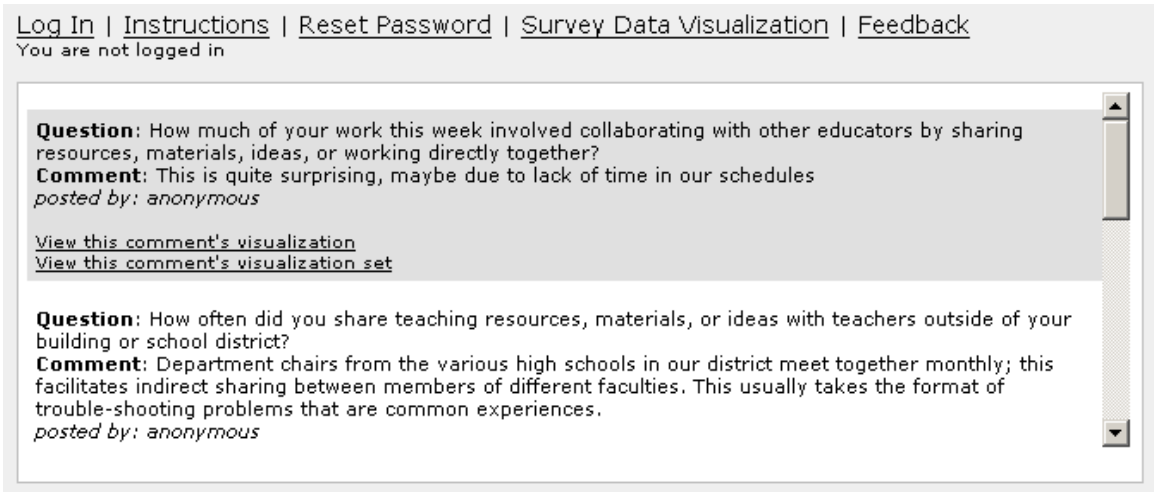


Figure 19 - Recent comments shown after link clicked

Each row in the recent comments list consists of five components: the question the comment is associated to, the comment itself, the author of the comment, a link to the visualization of the question used when the comment was submitted, and a link to the visualization set used when the comment was submitted. The colors of these rows alternate between white and gray which act as a sensory affordance [22], helping the user quickly identify the components of a recent comment.

3.2.3.6 Ajax Framework Design Concerns

A common complaint about Ajax applications is that it is not possible to directly link to a specific state of an application. In the researcher version of the Survey Data Visualization Tool, there was no way to link directly to a specific visualization. If one researcher wanted to discuss the survey results with another researcher, the specific query parameters, i.e., the survey, the users, the questions, and the visualization type, would have to be shared rather than proving a direct link to a visualization set.

To address this situation in the teacher version of the Survey Data Analysis Tool, additional code was implemented to handle this need for "deep-linking", i.e., linking directly to a specific visualization or a visualization set. Above each visualization set is a link reading "Link directly to this visualization set", which displays every visualization displayed when the user posted the comment, and after each survey question visualized is a link reading "Link directly to this particular visualization of this question", which only displays the question the comment was posted in reference to.

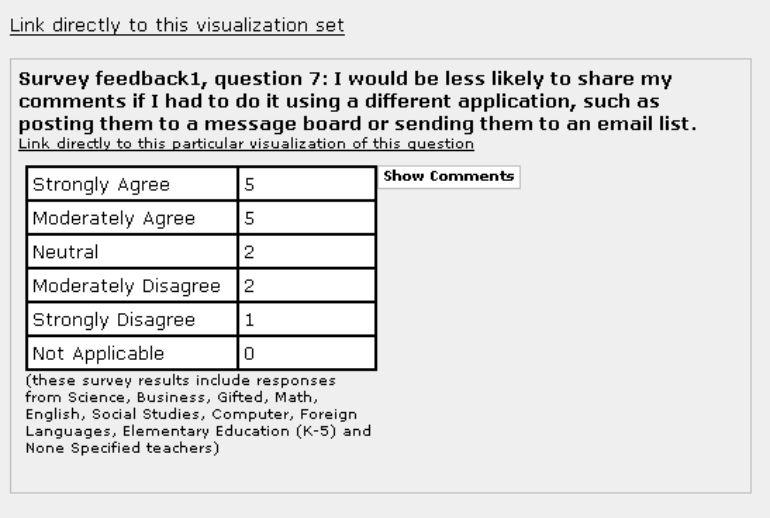


Figure 20 - Visualization with deep linking mechanisms implemented

This deep-linking mechanism is also used in the recent comments list described in Section 3.2.3.5.

Deep-linking to a previously viewed visualization presented a problem that was not present when a user generated a visualization themselves: directly linking to a visualization removes any contextual information about how the visualization was generated. For instance, clicking the following link,

http://anxiousplanet.com/thesis/SurveyViz.php?surveyID=13&vizType=pie&surveyList=-13&userList=-1-2-4-5-6-8-10-13-14-15-19-20-23-28-29-31-33-36-39-47-48&questionList=-15#vizSection

generates the following visualization:

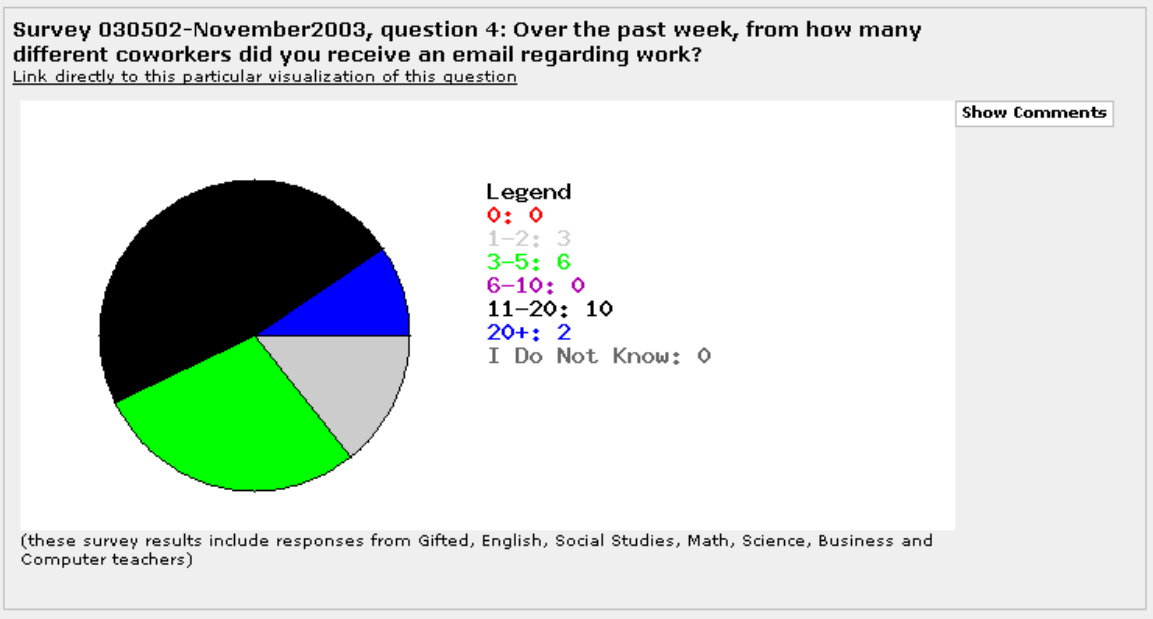


Figure 21 - Specific visualization generated by clicking the link above

Without any contextual clues, the participant who followed the link would only know the survey and the question number the visualization was generated in reference to. To address this, I added the list of teacher types that were included in the visualization generation below each visualization, as shown in Figure 21 above.

This deep-linking adds an additional means of accessing both the visualization activity and the information capture/dissemination features of the tool. Using the recent comments list discussed in Section 3.2.3.5, a teacher can quickly view a visualization generated by a peer, view the comments associated with the visualization, and add his/her own comments to the visualization. Deep-linking also allows a teacher to engage in the visualization activity with his/her coworkers. After generating a visualization, a teacher can take the link, open their email program, and send the link to a colleague.

3.2.3.7 Navigational Menu

Since the teacher's version of the Survey Data Visualization Tool contains more than just the visualization page, I added a navigational menu to assist in making the tool's features easily accessible. The navigational menu differs slightly for users who are logged in and those who are not. Both versions have links to the tool instructions, the visualization page, and the feedback survey, which is discussed in Section 3.2.4. Additionally, both navigational menus report the user's status, either logged in or not logged in.

The "logged in" navigational menu provides a link that enables the user to access and modify their profile. It also provides a link to a page where the user can change their password.

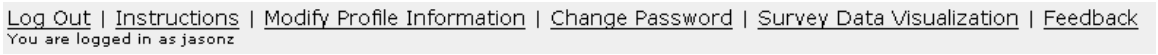


Figure 22 - "Logged in" Menu

The “not logged in” version of the navigational menu contains a link that directs them to a page which allows the user to reset their password to a random value.

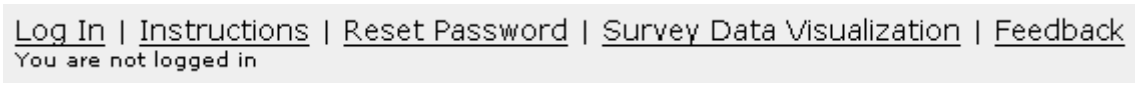


Figure 23 - "Not logged in" Menu

3.2.4 Feedback Survey

In order to fully understand teachers’ impressions of the tool and validate the reasoning behind the design parameters, I authored a feedback survey that is accessible from the navigational menu of the Survey Data Visualization Tool. The feedback survey covers usability and operational issues of the tool along with questions addressing knowledge management practices. Each question in the survey attempts to answer some part of the following question: Is the Survey Data Visualization Tool useful as a knowledge management tool for teachers?

Question 1: *I was able to generate survey visualizations quickly*: Since teachers have limited time they can spend on personal development, the time it takes for teachers to generate survey visualizations should be minimal. Additionally, the most important step in using the Survey Data Visualization Tool is viewing and commenting on the results, so teachers should spend as little time as possible to get to that step, thus making the speed of the generation of survey visualizations important.

Question 2: *I was able to generate survey visualizations easily*: There is an important distinction between this question and Question 1: speed and ease can be mutually exclusive, thus it is possible that a task be easy to complete, but take considerable time, and vice versa. At no time should teachers feel as if they are partaking in a chore.

Question 3: *When I generated a visualization, I was able to understand what I was looking at*: Ensuring that a user understands what he/she is looking at is of paramount importance to the successful development of any visualization tool.

Question 4: *If I needed to make a small change to the parameters used to generate a visualization and then generate a new visualization, I was able to do so quickly*: The tool was designed to save teachers time in every step of the visualization generation process. If a teacher wanted to view the results of math teachers for a given question, and subsequently view the results of science teachers for the same question, the teacher should only have to change one parameter to generate the new visualization.

Question 5: *There was too much information on the page*: As discussed in Section 3.2.2, I wanted to include everything on in order to reduce the amount of time it takes users to generate a visualization set. The less time a user spends generating visualizations, the more time they will have looking at the data, which means more time sharing and absorbing the communal knowledge embedded in the tool. Too much information on the page, though, could lead to information overload and thus slow the visualization generation procedure. Worse yet, this could frustrate the user to such an extent that they would stop using the tool altogether.

Question 6: *Seeing a comment posted next to a visualization made me more inclined to post a comment*: Encouraging participation is a challenging endeavor. The success of the tool can be linked, at least on some level, to the amount of teacher participation the tool encouraged. Clearly, the form of participation that is most easily identified is posted comments. I believed that if a teacher saw their coworkers participating, they would be more inclined to participate as they would not want to be "slacking" compared to their coworkers.

Question 7: *I would be less likely to share my comments if I had to do it using a different application, such as posting them to a message board or sending them to an email list*: Acquiring teachers' feedback regarding the survey data is a main goal of this research. I surmised that by providing an area where a teacher could submit his/her thoughts adjacent to each visualization would reduce the time barrier introduced by requiring the teacher to post their comments via a different medium, thus increasing the level of participation.

Question 8: *Other types of visualizations would help me understand the data better*: While the survey tool provides three different visualization types, there may be other visualizations aside from the raw data tables and the pie and scatter plots that convey the results of the data more effectively.

Question 9: *The survey questions had significance to my role as a teacher*: If the questions did not have significance to the participants using the tool, they would be less likely to use the tool on subsequent occasions.

Question 10: *Even though I didn't take the original surveys, I found the results informative*: Ideally, a knowledge management tool designed for teachers should present information that is useful to the teachers, regardless of the stage at which the teachers became involved with the information.

Question 11: *Being able to view the responses of specific types of teachers gave the visualizations more meaning to me*: As discussed in Section 3.2.3, a concerted effort was made to give the visualization results significant meaning to the participants. By being able to view the survey answers of specific types of teachers, I hoped that the participants would get more meaning from the survey results and thus post more comments.

Question 12: *I would be less likely to post a comment if people knew that I wrote it*: Not surprisingly, teachers, like anyone working in a group environment, are often hesitant to expose their opinions to their coworkers. Teachers cite the fear of having their opinions rejected, their judgment questioned, or their teaching methods ridiculed as reasons to this behavior [9]. This question seeks to explore whether or not this behavior is applicable to online knowledge management tools. Additionally, it also attempts to confirm the design decision to allow the posting of anonymous comments.

Question 13: *Using the tool helped me better understand the behavior of my peers*: A benefit of knowledge management tools and practices is the ability to learn how and why your coworkers do things. I hoped the tool would allow teachers to do this.

Question 14: *Using the tool helped me better understand my own knowledge*: While not a specific requirement, I would consider it a great success if the survey tool provided an opportunity to participants for valuable, worthwhile self-reflection regarding teaching practices.

Question 15: *Viewing the comments in the list of recently posted comments encouraged me to view the visualizations the comments were in reference to*: This question was specifically asked to verify the design decision discussed previously in Section 3.2.3.5.

After a user completes the feedback survey, the system encourages the user to create an active account. The user accomplishes this by following the Reset Password link and entering their email address in the space provided. Additionally, the system also encourages the user to generate visualizations for the feedback survey and comment on the results, just as they did for the surveys given initially.

I detail the feedback survey results in Section 4.4.

3.3 Encouraging Teacher Participation

Teachers from the TeacherBridge project (those who took the survey and those who did not) along with teachers not associated with the TeacherBridge project were invited via emails and personal interactions to use the Survey Data Visualization Tool. Initially, the teachers were not given any specific instructions on what I expected them to do with the tool. I wanted to see what teachers would do when given a tool without much instructions other than “here’s the tool, use it how you see fit.” Additionally, I posted both basic bulleted instructions and detailed instructions on the website in case teachers needed direction.

The next email I sent to the teachers contained more specific instructions about how to generate a visualization and post comments.

The last email I sent to the teachers contained a link to the survey and encouraged the teachers to “learn about what [their] peers are doing and saying”. Also, it provided a link

to the feedback survey and asked the teachers to take the feedback survey once they had used the tool.

4 Results and Discussion

In this section, I discuss how teachers used the Survey Data Visualization tool, including both the comments teachers posted via the tool and the results of the feedback survey that was given to the teachers directly after they used the tool.

4.1 Teacher Participation

Encouraging teacher participation was by far the biggest obstacle in performing this research. Most of the teachers I spoke to were apathetic towards knowledge management activities because they were not encouraged to partake in these activities by their supervisors. Since there was no encouragement, there was no incentive perceived by the teachers, other than the chance to help a graduate student with his thesis. After explaining the benefits of engaging in knowledge management activities and, in some cases, offering incentives (in the way of "bribes" such as coming to a class and either reading a story or talking about computers), teachers were more apt to participate in the study.

I was fortunate to have access to an elementary school where my mother worked and thus already had an established relationship with the teachers, either personally or through my mother. The teachers at this school were, on the whole, much more receptive to participating in the research and shared with me their thoughts and comments rather freely.

Conversely, the teachers who had been involved with TeacherBridge, including those who took the initial surveys, participated far less than I expected and hoped. The teachers who did participate were ones that I had a personal relationship with, either from past encounters via TeacherBridge or through interviews I conducted for this research. There were some cases, though, that regardless of the extent of my relationship with the teachers, some individuals did not participate. It was not possible to find out why these teachers did not participate since they were unresponsive to my inquiries.

My difficulty getting teachers to participate in research regarding knowledge management is yet another example of the innate difficulties researchers have introducing knowledge management practices into educational environments.

4.2 Tool Use

I initially asked the teachers to use the tool as they saw fit. I did not give much direction at all as I was interested in seeing how teachers would use the tool when left to their own devices. I observed that when you ask a teacher, "What do you want to do?", their answer is generally "Something other than work." Given this, it was not surprising that the level of participation was low before I gave teachers clear goals for using the tool.

I classify teacher participation for the Survey Data Visualization Tool on the following levels:

1. Teacher did not use the tool
2. Teacher used the tool but did not post comments nor communicate their impressions of the tool directly to me
3. Teacher used the tool and did not post comments but they communicated their impressions of the tool directly to me
4. Teacher used the tool and posted comments

Given the current architecture of the Survey Data Visualization Tool, it is impossible to analyze teachers who fall into categories 1 and 2 above, so they cannot be discussed. Possible solutions to tracking the participation of teachers who fall into category 2 are discussed in the Conclusions section of this thesis.

It cannot be said for certain whether there were more teachers who fell into category 3 than category 4 as every comment was posted anonymously, so there is no way to tell if one person posted every comment, if every comment was posted by one individual, or some combination thereof.

I did not want to create a knowledge management tool that was so rigid that it prevented participation, but I also wanted the tool not to be so loose that it was difficult to understand how the pieces of knowledge contained in the tool were related to one another. This was a difficult design requirement to achieve, and the problems inherent in it are most evident in the comments mechanism.

Consider the following visualization generated for the question *How often did you share teaching resources, materials, or ideas, with a group of coworkers?*:

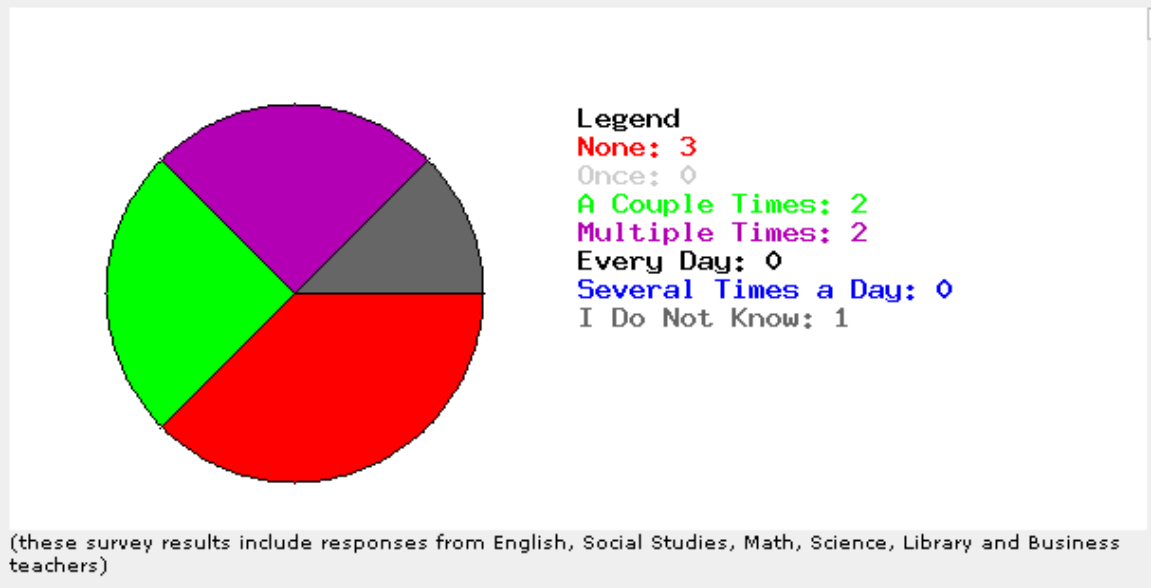


Figure 24 - One visualization for the question *How often did you share teaching resources, materials, or ideas, with a group of coworkers?*

One comment posted in response to this visualization was “This is not representative of my experience. We are sharing all of the above on a very regular basis.” Now consider the following visualization for the same question:

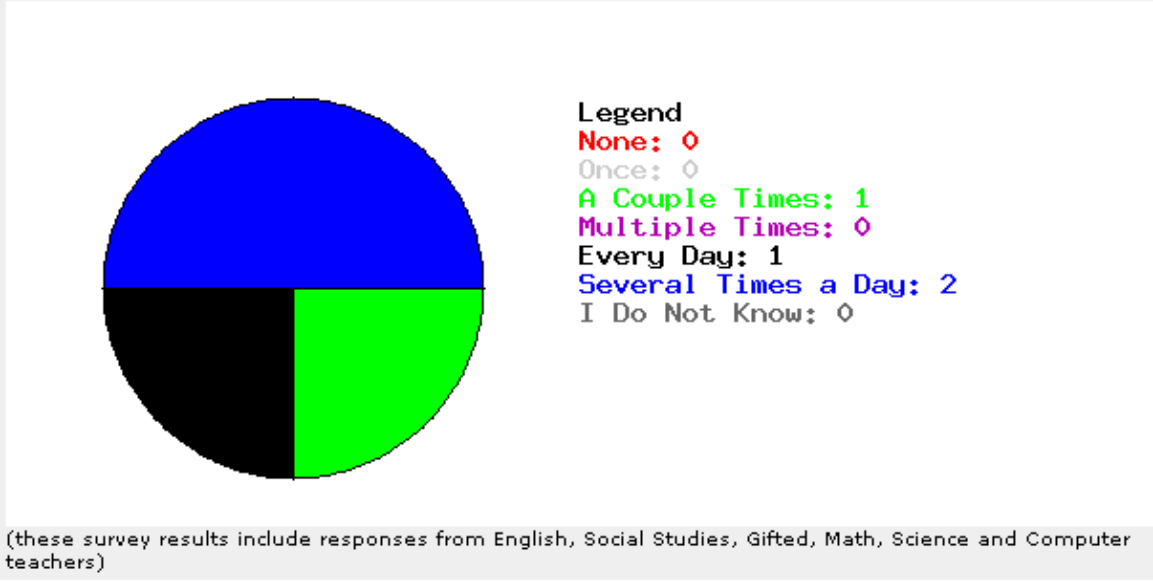


Figure 25 - Another visualization for the question *How often did you share teaching resources, materials, or ideas, with a group of coworkers?*

Clearly the second visualization does not agree with the previously mentioned comment, even though it is for the same question. The reason for the discrepancy is that the second visualization used the same question, but a different group of teachers and a different survey.

This ambiguity stems from the open-endedness of the comments themselves. Comments generally fall into one of three categories:

- Comments that are in reference to the survey question
- Comments that are in reference to the survey data
- Comments that are in reference to a previous comment

Possible solutions to the issue of comment ambiguity are discussed in the Conclusions section of this thesis. Discussion of the content of the comments is found below.

4.3 Comment Analysis

Although comments could feasibly fall into one of the three categories mentioned above, all of the comments submitted to the Survey Data Analysis Tool were either in reference to the survey question or to the survey data, but never in reference to a previous comment. The comments were approximately split between referencing the questions and referencing the data.

On the whole, the comments echoed common themes: time constraints were an issue, but teacher collaboration was certainly occurring. In response to the question "*Over the past week, how often did you access or engage in teacher related online resources or organizations (e.g. Tapped-In, TeacherBridge, Inquiry Learning Forum) over the past week*?", a participant wrote "Our librarian has been consistently sending us on-line resources that she discovers that may be of use to a particular department. Time constraints prevent me and my colleagues from searching these things out for ourselves on a regular basis." This is an example of a teacher with a desire to interact with online resources but without the time to do so. The librarian, on the other hand, does have the time to access these resources, and disseminates the information to her coworkers.

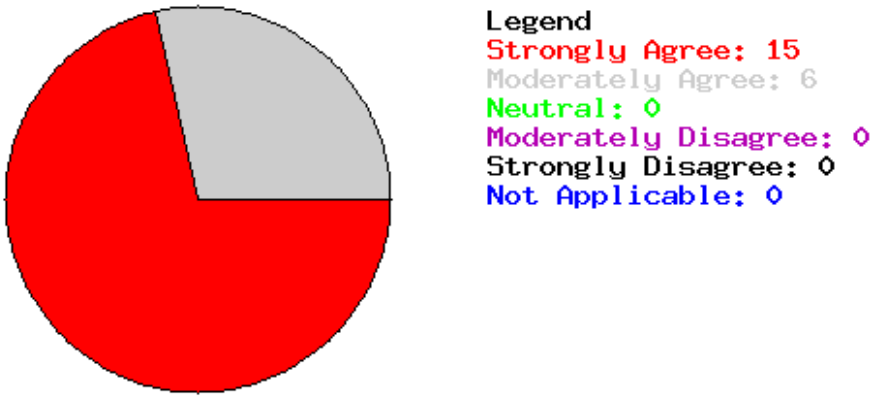
When a participant commented on the survey data, they always expressed whether they agreed or disagreed with the data, and they usually added their personal experiences that influenced their opinion. For example, for the question "*Over the past week, how often did you communicate in person or over the phone with other teachers about professional issues over the past week*?", one participant responded to the survey results with the following comment: "This surprises me that it does not happen more often. I know in my work place it is almost on a daily basis."

A list of all of the comments posted can be found in the first section of the Appendix of this thesis.

4.4 Feedback Survey Results

This section presents the results for each question in the exit survey. For a discussion of the generation of the survey questions, consult Section 3.1.

Question 1 - *I was able to generate survey visualizations quickly*



(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 26 - Results of feedback survey, question 1

All respondents agreed on some level that the visualizations were quick to generate, with nearly three-quarters of respondents strongly agreeing.

I believe that there should be more data. More people who took the original surveys.

posted by: anonymous

I was impressed that this tool worked quickly even with dialup -that is a plus (as some folks do not have faster connection - slow speed would hinder my use of tool)

posted by: anonymous

Figure 27 - Comments from feedback survey, question 1

The first comment has relatively little, if anything, to do with the survey question. This is a common problem with unmoderated knowledge management systems. While the statement is a valid one and worthy of further discussion, it was posted in the wrong place.

The second comment, on the other hand, addresses a concern that is often overlooked in recent years given the infiltration of high-speed Internet connections in homes and schools. Ajax framework-based applications require ongoing communication between the client computer and the server, and a dial-up connection could prove to be problematic if too much data were being transmitted in the generation of the visualizations.

Question 2 - *I was able to generate survey visualizations easily*

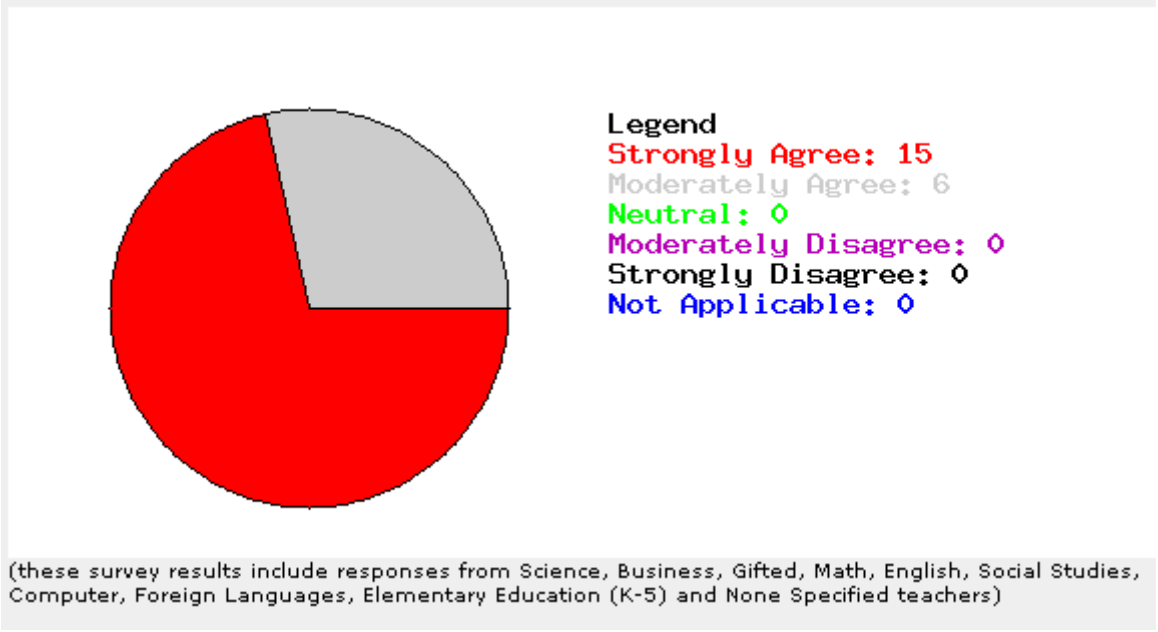


Figure 28 - Results of feedback survey, question 2

Again, almost three-quarters of respondents strongly agreed with the notion that they could generate visualizations easily, with the remainder of respondents moderately agreeing.

Question 3 - *When I generated a visualization, I was able to understand what I was looking at*

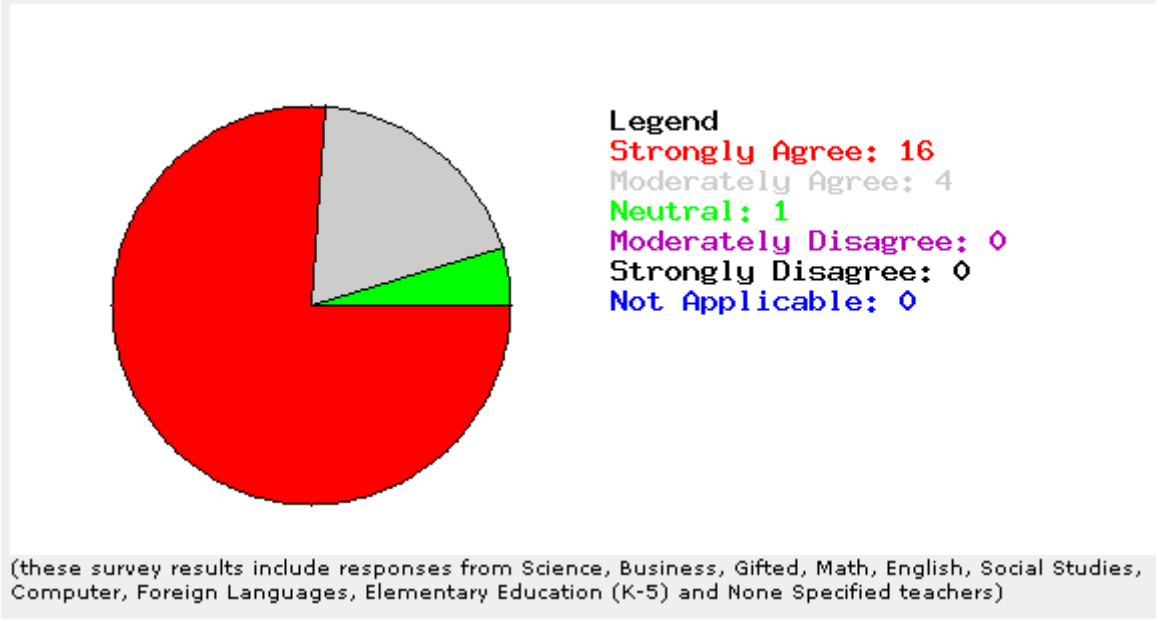


Figure 29 - Results of feedback survey, question 3

A visualization is worthless if it does not convey its intended meaning to those viewing it. Since all but one respondent agreed on some level with this statement (the only dissenter answering 'neutral'), and of those, more than three-quarters strongly agreeing with the statement, the visualizations appear to have conveyed their intended meaning.

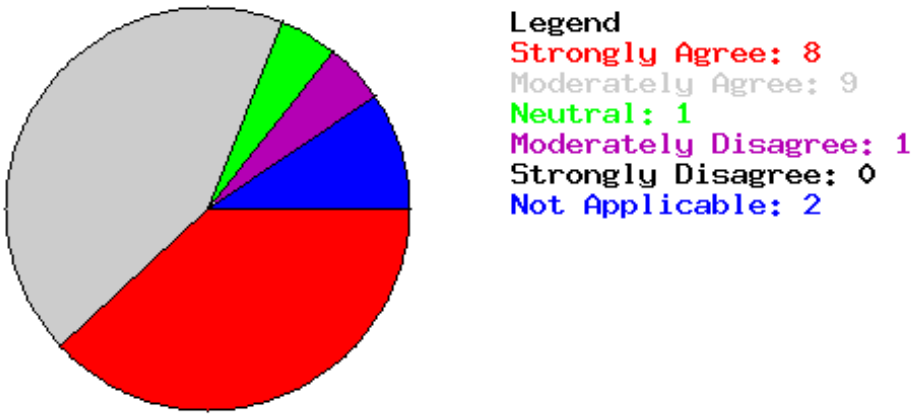
I liked to option of seeing raw data or the pie chart - learning styles and presentation preferences are an area teachers are taught to address with the children, but the teachers' preferences are often ignored in data sharing...

posted by: anonymous

Figure 30 - Results of feedback survey, question 3

This comment echoes the sentiment that teachers' needs are not taken into consideration often enough. Schools are generally preoccupied with student outcomes. These outcomes are clearly important as a school, ultimately, is responsible for educating students, but teachers' needs should not be overlooked since without effective teachers, students will not be educated effectively.

Question 4 - *If I needed to make a small change to the parameters used to generate a visualization and then generate a new visualization, I was able to do so quickly*

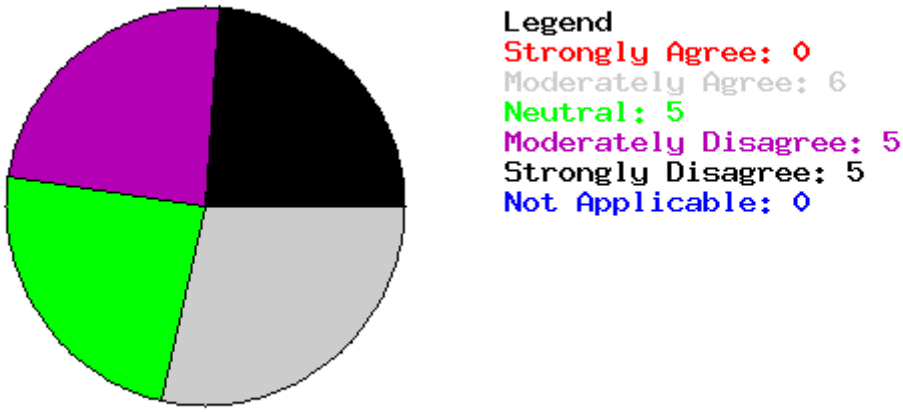


(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 31 - Results of feedback survey, question 4

As discussed in Section 3.2, a key design consideration was to enable the tool to allow changes to the visualization parameters without requiring the participant to undergo the entire process again. These results show that the tool was in fact designed appropriately in order to accomplish this.

Question 5 - *There was too much information on the page*

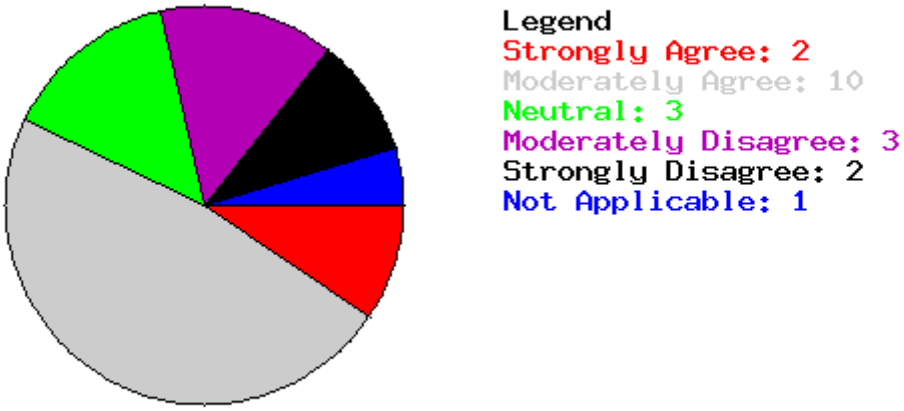


(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 32 - Results of feedback survey, question 5

Preventing information overload is a key concern when attempting to communicate information. There is a delicate balance between providing enough data to convey the desired information and providing so much information that the underlying concepts are lost. Ironically, too much information can reduce the efficacy of a knowledge management tool as a participant may become overwhelmed by all of the information, not knowing what they should focus on. A comment I received directly from a participant while I was designing the tool was that there was too much information on the page. We met to discuss her concerns and we eventually discovered that it was not the amount of information that was overwhelming, but the lack of direction regarding how to use that information that made information gathering difficult.

Question 6 - *Seeing a comment posted next to a visualization made me more inclined to post a comment*

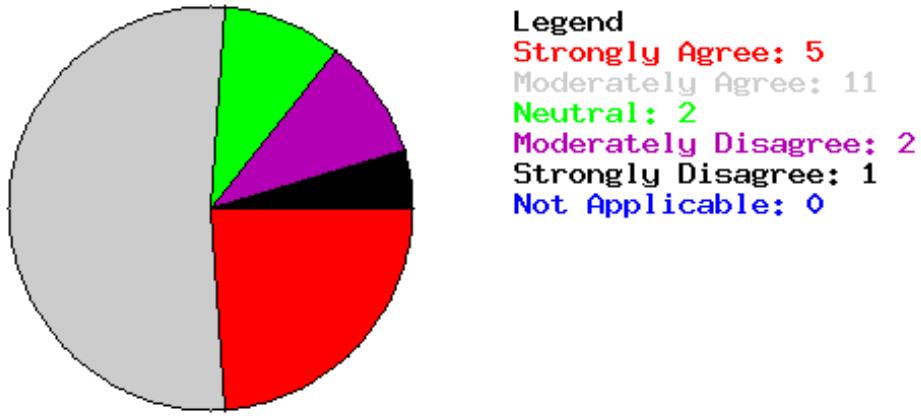


(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 33 - Results of feedback survey, question 6

The majority of respondents agreed that they were more likely to contribute a comment, thus participating more, if a peer had already posted a comment. Just under a quarter of respondents disagreed with this statement on some level, though.

Question 7 - *I would be less likely to share my comments if I had to do it using a different application, such as posting them to a message board or sending them to an email list*



(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 34 - Results of feedback survey, question 7

The majority of respondents agreed that their participation would likely increase if their participation did not require additional time accessing other knowledge management tools.

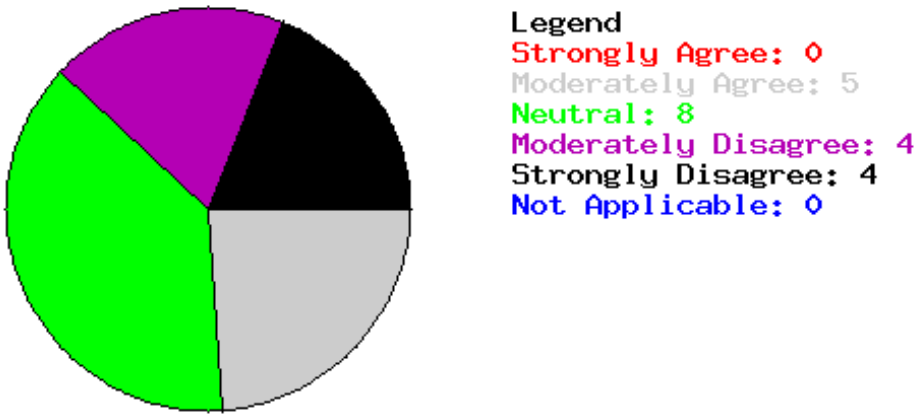
this tool is quick and easy to navigate - and the speed is faster than blackboard or other option

posted by: anonymous

Figure 35 - Comments from feedback survey, question 7

This comment is an example of how the comment system allows participants to further expand on survey questions and lead evaluation in a direction not previously identified by researchers. When I asked this question, I was hoping to show that teachers would be more likely to participate if they could reduce the time they spent accessing knowledge management tools. I was not concerned with existing knowledge management tools and how effective they were compared to the Survey Data Visualization Tool. With the comment system, though, a participant was able to answer a question that I had not considered asking, and thus helping to direct future inquisition.

Question 8 - *Other types of visualizations would help me understand the data better*



(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 36 - Results of feedback survey, question 8

Visualization preferences are highly dependent on each participant. I wanted to provide enough visualization options to convey the meaning behind the survey data while not spending an inordinate amount of time programming these options into the tool.

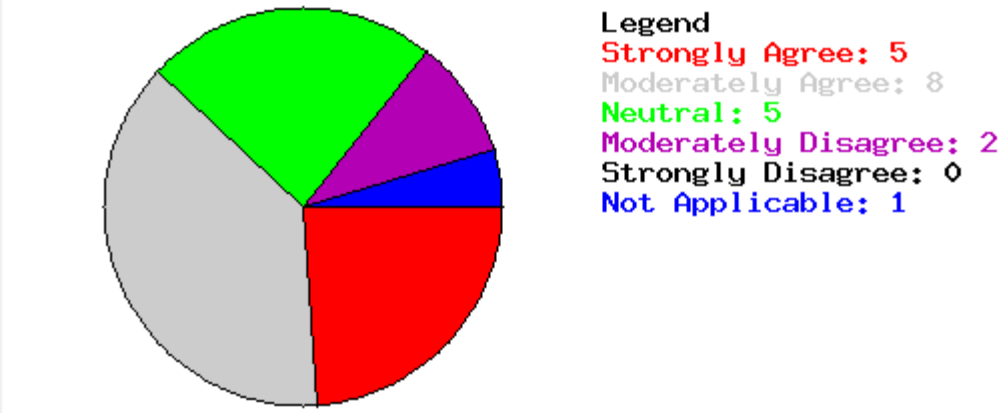
some folks might like the option of other visualization tools (plots, bar graphs, etc...) - probalby not difficult to design with your skill set

posted by: anonymous

Figure 37 - Comments from feedback survey, question 8

This comment echoes the varying responses to the survey question. While not necessarily important to the participant who posted the comment, some participants may find use in having additional visualization options. It is important to be mindful when designing a knowledge management tool, though, that at some point initial tool development needs to end in order to start tool use.

Question 9 – *The survey questions had significance to my role as a teacher*



(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 38 - Results of feedback survey, question 9

The majority of respondents agreed with this statement. This is important since participants are not likely to spend time using a tool that carries no meaning for them.

I was pleased to see how many K-12 teachers agreed that this info was significant to them -

posted by: anonymous

Figure 39 - Comments from feedback survey, question 9

This participant used the ability to view survey results by specific teacher types and then posted a comment in reference to that particular visualization. The participant here used the comment section as an avenue to comment on the results of the feedback survey,

though it is unknown how much time passed between when the participant took the survey and when they viewed the results of the survey. This comment is an example of how the survey tool enables feedback loops between the researchers and survey participants and the survey participants as a group.

Question 10 - *Even though I didn't take the original surveys, I found the results informative*

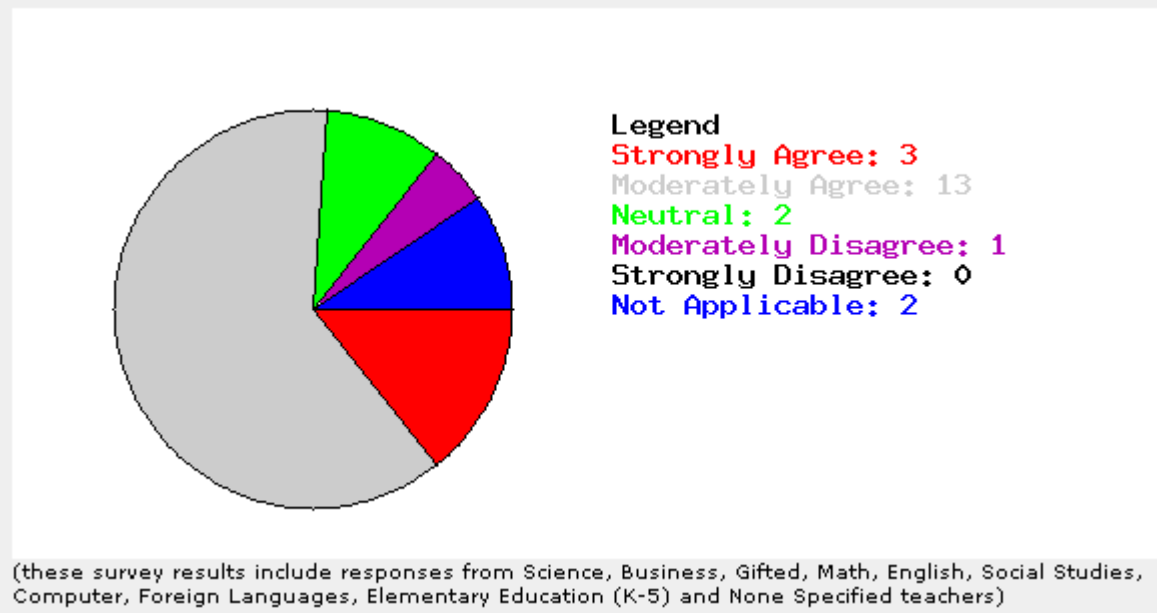
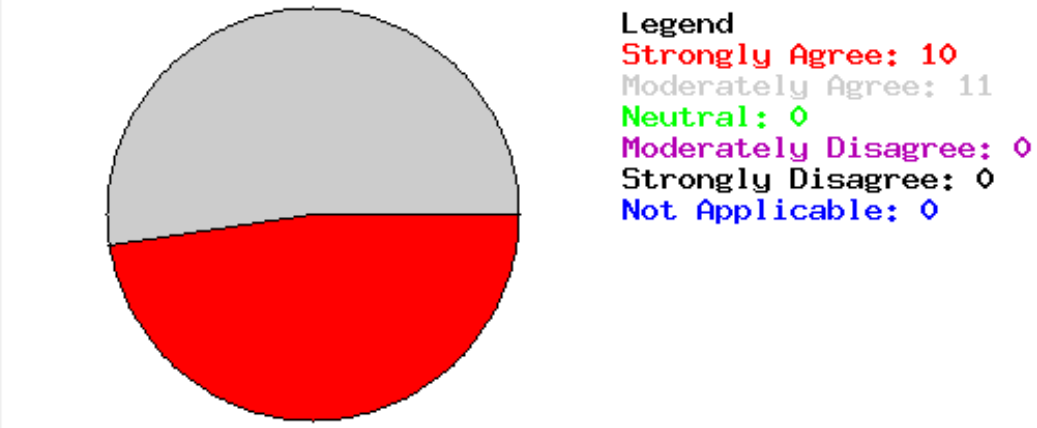


Figure 40 - Results of feedback survey, question 10

The success of a knowledge management tool can be measured in a number of ways, one of which being how pertinent the users find the information contained in the tool. Since a large majority of survey participants agreed that they found the data presented by the tool to be informative, the tool was at the very least successful in that regard.

Question 11 – *Being able to view the responses of specific types of teachers gave the visualizations more meaning to me*

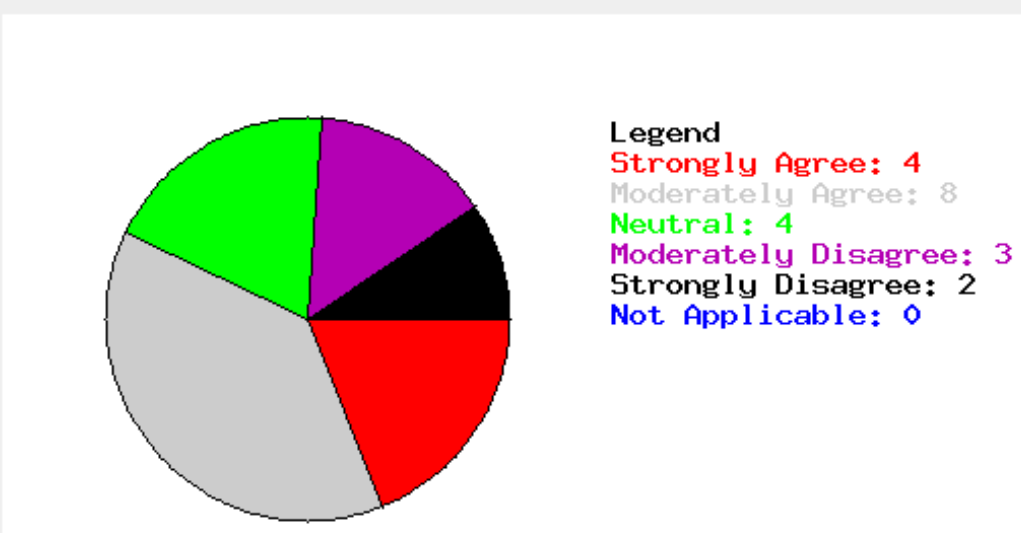


(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 41 - Results of feedback survey, question 11

While designing the tool for educator use, I theorized that by giving the teachers the ability to identify with survey respondents would get them more interested in the results of the survey. Since every participant agreed with this question, it would appear that my assumption was correct.

Question 12 – *I would be less likely to post a comment if people knew that I wrote it*

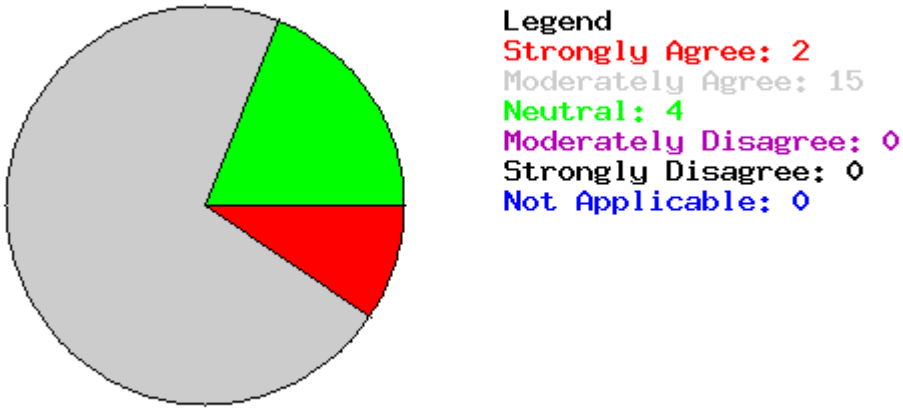


(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 42 - Results of feedback survey, question 12

Approximately only one-quarter of respondents disagreed with this statement. The results of this question may explain why every single comment posted was done so anonymously. Because teaching is a social working environment, teachers may be hesitant to share information that others may object to. As one teacher related, "Sometimes teachers are reluctant to bring issues up in front of the whole staff for fear that it may offend other teachers and make the working relationship uncomfortable. Teachers often rely upon each other to cover classes or change duties, e.g., bus duty, d-hall, lunch duty, et cetera. There may be a fear that if these issues are brought up, then some teachers may not be as cooperative in other areas. [25]"

Question 13 – *Using the tool helped me better understand the behavior of my peers*

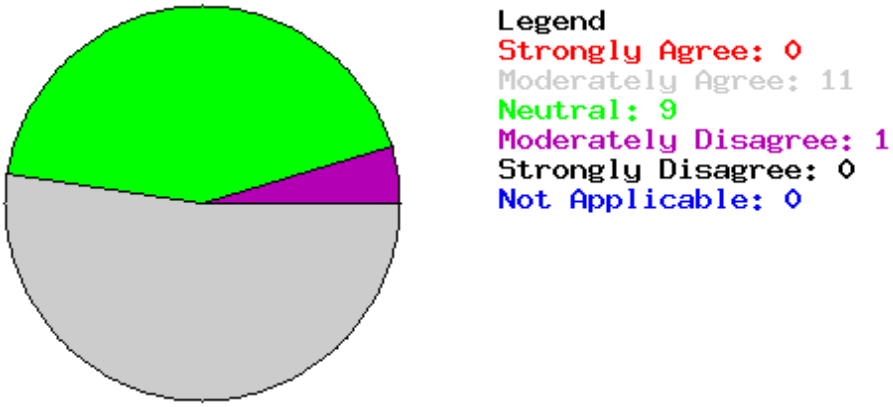


(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 43 - Results of feedback survey, question 13

A better understanding of peer behavior might give teachers an opportunity to supplement their existing teaching practices. Or it might simply help one teacher better understand the classroom practices of their coworkers. Regardless of how this understanding is used, the tool was successful in conveying coworkers' behavior to their peers.

Question 14 - *Using the tool helped me better understand my own knowledge*

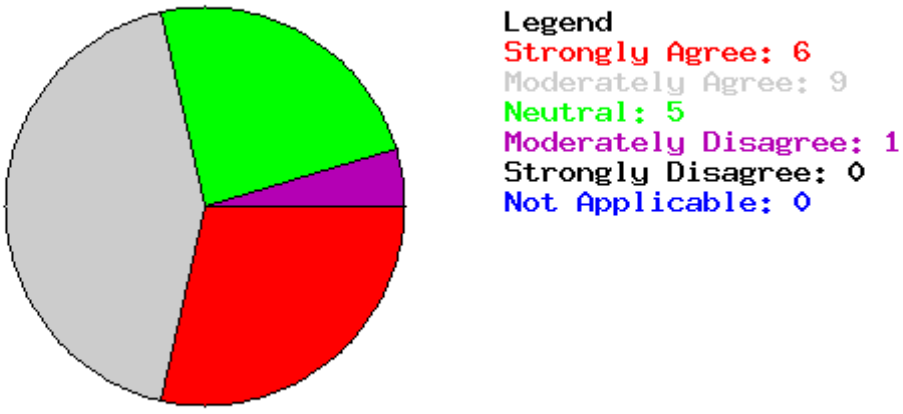


(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 44 - Results of feedback survey, question 14

The idea behind this question was to see if teachers who reflected on the responses of their peers would be likely to reflect on their own practices. I am not sure if I worded the question effectively, though a slight majority of respondents did agree with the statement.

Question 15 – *Viewing the comments in the list of recently posted comments encouraged me to view the visualizations the comments were in reference to*



(these survey results include responses from Science, Business, Gifted, Math, English, Social Studies, Computer, Foreign Languages, Elementary Education (K-5) and None Specified teachers)

Figure 45 - Results of feedback survey, question 15

The list of recently posted comments was designed to give the teachers an easy avenue to viewing what other teachers had previously posted. I hoped that this directed examination of knowledge might give participants direction in how they used the Survey Data Visualization Tool if they did not already have a direction they wanted to follow. Given the results, I would say that this feature was successful in its intentions.

5 Conclusions

In this section, I reevaluate the knowledge management landscape in education in the context of this research. I also examine the successes and failures of the Survey Data Visualization Tool and present possible avenues for future work.

5.1 Addressing Social Concerns

Establishing better knowledge management practices within a school system requires both social and technological changes as tools alone cannot change the paradigm in which teachers work. As argued by Schwab, Minnet, Hawkins and others, a clear plan must be implemented using a top-down approach, starting with the school administration and moving downwards to the teachers. If administrators do not give full support and structure to collaborate to teachers who are apt to do so, are these teachers likely to abandon their collaborative nature?

The administration should strive to be involved in knowledge management activities when possible. Teachers I spoke with commented that if their supervisor were to offer them an incentive, such as coming to their classes and reading a story, they would be more willing to participate in knowledge management activities [9]. These non-monetary incentives can be effective towards encouraging teacher collaboration without requiring any additional drain on resources other than the time of the supervisor. Additionally, any incentives teachers might attain from participating in knowledge management activities must be easily perceivable, at least from the onset of their participation.

If researchers are to expect teachers to be active participants in knowledge management activities, a culture of collaboration should be fostered within the teaching community, starting before teachers start working, when they begin their education on the road to becoming educators. One teacher I spoke with, who had no involvement in the TeacherBridge project, had recently attained her Master's degree in education. Throughout her education, both undergraduate and graduate, there was little to no discussion regarding knowledge management [26].

One thing that I did not stress enough to the teachers was the notion of student benefits. It is logical to conclude that being a better teacher eventually affects your students, but that outcome is not necessarily clear to someone who is being asked to do more in an already overloaded schedule. Reminding teachers of the benefits knowledge management practices can produce in regards to student outcomes such as, "If you use this tool, you will learn about how your peers handle disruptive student behavior in the classroom," is certainly a worthwhile step in encouraging teacher participation in these practices. Addressing participation concerns through technological means is discussed below.

5.2 Addressing Technological Concerns

It is important that researchers be mindful that technology cannot completely compensate for lacking social skills. As described by Dunlap, et al, the planning tool they developed in their work with teachers drew on "a complex set of social skills and practices for its success" [27]. Technology may help to overcome minor social issues, but it certainly cannot completely negate them.

5.2.1 Gauging Teacher Response

It is problematic to ask a teacher "Did you benefit from using this tool?" for numerous reasons. One, a teacher may not immediately, or even eventually, realize the benefits of using knowledge management tools. Two, a teacher may have difficulty articulating benefits she may have experienced while using a knowledge management tool. Researchers should seek teacher impressions of knowledge management practices in manners that encourage the teacher to convey their ideas using language that they are comfortable with. Understanding knowledge management behaviors should be both an exploration and an education.

5.2.2 Participation Issues

As discussed in Section 4.1, it was difficult to find out how a teacher felt about knowledge management practices when I could not get them to participate in knowledge management research. I found two methods that were especially successful in encouraging knowledge management participation:

Establish a Connection: This method by far yielded the best results. Nearly every teacher who I had had face-to-face contact with participated in this research. Furthermore, they participated on a greater level than other participants, such as emailing me directly and posting multiple comments to the Survey Data Visualization Tool.

Provide Incentives: Many teachers were eager to participate when I promised them something in return, usually in the form of coming to their classroom and talking with their students, thus giving them a bit of much-needed free time during their day.

I believe these two methods to be paramount in encouraging teacher participation in knowledge management activities. Teachers need to have some sort of connection to the knowledge they are being asked to share and they need to get something out of sharing this knowledge.

Additionally, teachers need to be given clear, precise instructions and tasks. Asking them to just "play" with a tool will likely encourage them to do the opposite. Teachers should also be encouraged to share their experiences using knowledge management tools with their peers, either by discussing their impressions of the tool or just simply mentioning the tool. This was something that I did not think to encourage, though I now realize it could have helped in garnering additional participation from teachers.

The reluctance to take ownership of knowledge in a field where knowledge is the main commodity is one that should be explored further. I assume, though, that the problem stems more from sociological issues rather than work-environment issues, such as a need to protect their reputation among their peers. These issues could feasibly be addressed by incorporating a system as presented by Minnett, where an environment of collaboration is not only encouraged, but expected and required. Still, allowing anonymous posting at least allows the spread of information where it might not have occurred without it. It could be argued (and should be explored in future research) that web-based knowledge management tools such as the Survey Data Analysis Tool help avoid conflict among peers due to their ability to provide anonymous means of collaboration.

5.3 Future Work

Given the results of this research, I have identified several areas in which future work can be directed, both specifically towards the Survey Data Analysis Tool and areas of knowledge management in education in general.

5.3.1 Tool Improvements

The Survey Data Analysis Tool can be improved in several areas to better support participant usability and thus better encourage overall participation:

5.3.1.1 Comment System Improvements

5.3.1.1.1 Provide Additional Visualization Functionality

In addition to the functions expressed in the Information Visualization Mantra, Shneiderman presents three additional useful tasks that information visualization tools should provide: *Relate*, *History*, and *Extract* [19]. The *Relate* functionality enables users to view the relationships among items in the visualization. The *History* functionality provides "breadcrumbs" – a list of previously viewed visualizations. The *Extract* function allows users to select pertinent portions of visualizations while removing the extraneous parts.

5.3.1.1.2 Provide Specific Links with Each Comment

As discussed in Section 3.2.3.4, comments occasionally do not correspond to the survey data due to the way I chose to associate them with each question. Links to the survey visualization used to generate the comments, as provided in the Recent Comment List, which was discussed in Section 3.2.3.5, could be added beneath each comment to reduce ambiguity.

5.3.1.1.3 Add Navigation to the Recent Comments List

The current implementation of the Recent Comments List described in Section 3.2.3.5 only displays the last five comments that were posted to the tool. If a participant wanted

to see any other comments, he would need to generate visualizations and hunt through them. To address this, simple navigation should be added to the Recent Comments List. Below the list, two links reading "Next Five Comments" and "Previous Five Comments" should be displayed, where appropriate.

5.3.1.1.4 Comment Browser

There are two sources of information within the Survey Data Analysis Tool: the survey results and the comments posted by participants. The survey results can be displayed readily by generating visualizations, but the comments can only be viewed either in the Recent Comments List or after generating a visualization. The solution to this problem is to develop a Comment Browser, where a user can access the comments without being required to generate a visualization first. The Comment Browser should somewhat mimic the functionality of a discussion board, using the survey questions as threads and the comments as replies in those threads. The Comment Browser should also be capable of searching the comments in the tool.

5.3.1.2 Visualization Concerns

As exhibited by the results of question 8 of the feedback survey, additional visualization options would be helpful in future revisions of the Survey Data Analysis Tool. A bar graph is a simple addition that could be made without requiring excessive programming effort.

Functionality could be added to the scatter plot to make it a more effective visualization tool. As discussed in Section 3.2.2, the researcher version of the tool contained a scatter plot visualization which displayed a legend next to the plot detailing how each participant answered the survey question. This legend should be added in some form to the current version of the tool, either displaying participants' user IDs along with the subjects they teach or just the subjects they teach. Moreover, an option can be added to add or remove a single user at a time from a scatter plot without having to generate the visualization again. Last, the scatter plot visualization should allow the tool user to connect data points with lines to aid in the better understanding of the visualization.

The Survey Data Analysis Tool could also allow for "reverse queries", where the tool user essentially asks the question, "Show me the people who answered X for question Y".

5.3.1.3 Better Logging

In Section 4.2, I discussed the classifications of tool users. Obviously, I cannot track users in category 1 since there is nothing to track, but with modifications to the tool, it would be possible to track users in category 2. With PHP scripting, it is possible to record every page visit by every tool user. For each page visit, the tool could record the IP address of the visitor and the page he is visiting. The same could be done for each visualization in order to track what data are being viewed. Dynamic IP addresses assigned by ISPs and proxy servers found at most schools, though, could make it problematic to effectively discern one user from another at these locations. Because of

this, it might be worthwhile to track users' activities on a per-session and per IP address basis.

Another solution to better tracking of users' activities would be to require users to log in every time they used the tool. I would surmise, though, that while this requirement would allow tracking with 100% accuracy (save for multiple users sharing an account), it would probably reduce overall participation. The system should keep track of every time a user logs into the system. This could be done simply by creating a MySQL table which records the teacher's user name and the time when they logged in.

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7 Appendix

7.1 Teacher Comments

Comment Number	Survey Question	Comment Text	Comment Type
1	The survey questions had significance to my role as a teacher.	I was pleased to see how many K-12 teachers agreed that this info was significant to them -	Data
2	Other types of visualizations would help me understand the data better.	some folks might like the option of other visualization tools (plots, bar graphs, etc...) - probalby not difficult to design with your skill set	Data
3	I would be less likely to share my comments if I had to do it using a different application, such as posting them to a message board or sending them to an email list.	this tool is quick and easy to navigate - and the speed is faster than blackboard or other option	Question
4	When I generated a visualization, I was able to understand what I was looking at.	I liked to option of seeing raw data or the pie chart - learning styles and presentation preferences are an area teachers are taught to address with the children, but the teachers' preferences are often ignored in data sharing...	Question
5	I was able to generate survey visualizations quickly.	I was impressed that this tool worked quickly even with dialup -that is a plus (as some folks do not have faster connection - slow speed would hinder my use of tool)	Question
6	How much of your work this week involved collaborating with other educators by sharing resources, materials, ideas, or working directly together?	This is quite surprising, maybe due to lack of time in our schedules	Data
7	Over the past week, how often did you share teaching resources, materials, or ideas with teachers outside of your building or school district?	Department chairs from the various high schools in our district meet together monthly; this facilitates indirect sharing between members of different faculties. This usually takes the format of trouble-shooting problems that are common experiences.	Data

8	I was able to generate survey visualizations quickly.	I believe that there should be more data. More people who took the original surveys.	Data
9	Over the past week, how often did you share ideas such as lesson plans, teaching objectives, or thoughts about an activity with another coworker?	From my experience, the educators that I have known over the years tend to share on a regular basis, so I do not find these results unusual at all.	Data
10	Over the past week, how often did you did you exchange instant messages or chat online with coworkers about professional issues in the past week?	Does this happen during the school day?	Question
11	Over the past week, from how many different coworkers did you receive an email regarding work?	The internet makes it easy to interact with large numbers of coworkers at one time. I have 29 other gt specialists that use "reply all" on a regular basis when responding to their team email.	Question
12	Over the past week, how often did you use other coworkers to help obtain teaching resources or to ask for advice about professional issues?	I find this easy to believe. As a gifted ed specialist I'm in contact with my team every day as well as several times each day.	Data
13	Over the past week, from how many different coworkers did you receive an email regarding work?	Wow, A high number, but perhaps gifted teachers have more flexibility in their curriculum where they can discuss feedback.	Data
14	Over the past week, from how many different coworkers did you receive an email regarding work?	Numbers seem low	Data
15	Over the past week, how often did you share teaching resources, materials, or ideas with teachers outside of your building or school district?	Not often maybe a few times a year if we see each other at district meetings.	Question
16	Over the past week, how often did you share teaching resources, materials, or ideas with a group of coworkers?	Daily	Question
17	How much of your work this week involved collaborating with other educators by sharing resources, materials, ideas, or working directly together?	Almost daily or sevel times a day.	Question
18	Over the past week, how often did you communicate in person or over the phone with other teachers about professional issues over the past week?	This surprises me that it does not happen more often. I know in my work place it is almost on a daily basis.	Data

19	Over the past week, approximately how many people did you communicate with this week via the Internet for work reasons?	About 2.	Question
20	Over the past week, how often did you work directly with other teachers on the same project?	On inservice days sometimes.	Question
21	Over the past week, how often did you share teaching resources, materials, or ideas with teachers outside of your building or school district?	On rare occassions when we would visit other schools. Once or twice a year.	Question
22	Over the past week, how often did you share teaching resources, materials, or ideas with a group of coworkers?	We are starting a new math program. The teachers teaching the new material are sharing everyday.	Question
23	How much of your work this week involved collaborating with other educators by sharing resources, materials, ideas, or working directly together?	Maybe once or twice a week.	Question
24	Over the past week, how often did you email with another co-worker about a professional issue?	Maybe once a week.	Question
25	Over the past week, how often did another teacher ask you for help or advice about professional issues or use you to obtain teaching resources?	Maybe once a week.	Question
26	Over the past week, how often did you communicate in person or over the phone with other teachers about professional issues over the past week?	Very rarely.Either in person or by e-mail.	Question
27	Over the past week, how often did you send or read email from a listserve for teachers?	Just about evryday.	Question
28	Over the past week, how often did you share teaching resources, materials, or ideas with a group of coworkers?	This is not representative of my experience. We are sharing all of the above on a very regular basis.	Data
29	How much of your work this week involved collaborating with other educators by sharing resources, materials, ideas, or working directly together?	On an average week, this occurs multiple times.	Question

30	Over the past week, how often did you email with another co-worker about a professional issue?	Because we are in the initial years of a new textbook series, we are using email quite a bit to send each other plans, activities, exams, etc. that we've created.	Question
31	Over the past week, how often did another teacher ask you for help or advice about professional issues or use you to obtain teaching resources?	Because we have a large number of young, inexperienced teachers in our building, the experienced teachers are providing a great deal of help and advice.	Question
32	Over the past week, how often did you access or engage in teacher related online resources or organizations (e.g. Tapped-In, TeacherBridge, Inquiry Learning Forum) over the past week?	Our librarian has been consistently sending us on-line resources that she discovers that may be of use to a particular department. Time constraints prevent me and my colleagues from searching these things out for ourselves on a regular basis.	Question
33	Over the past week, approximately how many people did you communicate with this week via the Internet for work reasons?	This reflects what is happening in my school district.	Data
34	Over the past week, how often did you work directly with other teachers on the same project?	This is not representative of my situation at all. The experienced teachers work directly with the less experienced teachers on a very regular basis.	Data
35	Over the past week, how often did you share teaching resources, materials, or ideas with teachers outside of your building or school district?	While we occasionally share information with the middle school teachers in my school district, most of the collaborating that takes place is within the high school itself.	Question
36	Over the past week, what percentage of your time at work this week involved collaborating with other educators either by sharing resources, materials, or ideas, or working directly together on a project?	I am surprised that there isn't more collaboration between colleagues. I wonder if the length of time a person has been teaching has any bearing on this. Those who have been teaching longer may not feel the need to collaborate as often as those who are newer to teaching?	Data

37	Over the past week, how often did you share ideas such as lesson plans, teaching objectives, or thoughts about an activity with another coworker?	These results are not too surprising, most collaboration I've encountered comes at the start of the school year or around a major holiday/team theme event. Department meetings rarely involve lesson content and focus more heavily on standardized test preparation.	Data
38	Think of the web pages that you visited over the past week for work reasons. Approximately what percentage of these contained information posted by other educators?	I don't find this surprising at all - most teachers in my department (mathematics) teach multiple levels of students and grades and lack the time necessary to make substantial contributions to their very own webpages outside of contact information.	Data

7.2 Interviewed Teacher Details

Teacher Name	School	TeacherBridge Participant	Relationship with Author
S. Baker-Williams	Horizon Elementary School	No	Professional
P. Dail	Horizon Elementary School	No	Professional
J. Hollick	Private Tutor	No	Friend
S. Mauney	Blacksburg Middle School	Yes	Professional
J. Simmons	Christiansburg High School	Yes	Professional
R. Zietz	Horizon Elementary School	No	Mother