DESIGNING THE CENSUS BUREAU WEB HIRING QUESTIONNAIRE: A CASE STUDY

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Key words: Web surveys, Internet, questionnaire design, usability testing

Introduction

Beginning in the 1980's, government statistical agencies and survey organizations began to test and then utilize computerized self-administered questionnaires (CSAQ) for data collection (Couper and Nicholls 1998). This trend continued to increase during the 1990's (Ramos, Sedivi, and Sweet, 1998; Couper and Nicholls , 1998; Collins, Martin, Sykes, and O'Muircheartaigh, 1998; Clark, Martin, and Bates, 1998). One obvious application for CSAQs is the Internet or World Wide Web (WWW). For users with Internet access and browser capabilities, this mode allows access by respondents virtually anywhere in the world.

But questionnaire designers for survey organizations and statistical agencies alike are discovering that the successful migration of a paper and pencil interview (PAPI) to a web-based application requires much more than simply converting the paper instrument to an on-line format (Hix and Hanson, 1993). Web surveys use different layouts and navigational conventions than PAPI surveys (e.g., a mouse, scroll bars, frames, hyperlinks). Consequently, survey designers must often reconsider question orderings, formats, and even question wordings and instructions. This paper concentrates on the design challenges of creating a user-oriented Web questionnaire.

A good way to assess user orientation and acceptance (and at the same time improve a CSAQ design) is to implement a test method commonly referred to as 'usability testing'. The practice of usability testing computerized survey instruments is fairly new (Bosley, Conrad and Uglow 1998; Hansen, Fuchs, and Couper 1997; Stone and Fisher 1997; Sweet, Sedivi, VanDerveer, Soper and Zhang, 1997; Couper 1994). However, usability testing has long been a part of the larger discipline of human-computer interface (HCI) research and design (e.g., computer software interfaces, electronic interfaces, information retrieval interfaces, see Nielsen and Levy 1994; Dumas and Redish, 1993; Dumas 1990). In the context of computer-assisted interview (CAI) design, usability testing is essential to create an interviewer or self-administered interface that is easily navigated and one where data entry errors are minimized, questions and instructions are clear, skip patterns are easily recognized, and help menus and function keys are useful.

Usability tests for CAI interfaces involve a series of iterative one-on-one tests with interviewers (for computer-assisted telephone interview or computer-assisted personal interview interfaces) or typical respondents (in the case of a CSAQ interface). In one form of the method, participants are asked to perform a series of tasks with a prototype of the interface while researchers observe and record the participant's performance. Time-task completion, navigational errors, data entry mistakes and keyboard, icon, and mouse manipulations are recorded. In a slightly different method, respondents may be asked to 'think-aloud' as they perform tasks, read and answer survey questions, and consult instructions, menus, and windows. Together, these methods help revise wordings for questions, answer categories and instructions, and gain a better understanding of how to improve interface layouts and navigational portions of the instrument. Ideally, iterative usability testing should occur before the formal design stage of a CAI interface, again during the initial prototype stage and then again during a retesting stage (Wixon et al., 1990).

Iterative usability testing that examines both the cognitive and computerized interface of the instrument is what we strive for under ideal circumstances. However, timing and resource constraints, and unfamiliarity or resistance to new test methods often prevent this from taking place before a CAI instrument is fielded. What are the consequences of circumventing usability tests? We examine this by describing a case study from the U.S. Census Bureau. In this case, a paper and pencil questionnaire used to self-assess job applicants was automated to a Web-based application. HCI-oriented testing did not occur prior to the conversion to the Web. The resulting Web application, a subsequent re-design that *did* include usability testing, and an assessment of differences between the two are described in the remainder of this paper.

The Case Study

During the Summer of 1997, the Census Bureau decided to move its system for collecting applications for mathematical statisticians to the USAJOBS Internet site maintained by the Office of Personnel Management (OPM). Soon after, the application process for survey statisticians and computer specialists was moved to the OPM system as well. A series of self-assessment questions, divided into background, qualification, and occupational-related questions are used to gather the applicant's information. For example, the questionnaire ascertains level of statistical computing skills on a variety of software packages by providing a four-point scale (no experience/beginner level/intermediate/advanced). Census managers supplied questions to assess applicants' statistical training and experience (i.e., the occupational questions) while standard OPM questions were used to determine applicants' qualifications at various grade levels (i.e., the qualification questions).

The instructions, qualifications, and self-assessment questions for these three job series were contained within a vacancy announcement posted on the USAJOBS Internet site. Those applicants wishing to apply on-line were instructed to connect to a Uniform Resource Locator (URL) on the USAJOBS site. The site contained a generic data entry template in Hyper Text Mark-Up Language (HTML). This on-line application was fashioned directly after a mark-sensing readable paper form (a 'bubble' form) used for other federal job applications. Because the Web application was not tailored to any particular job opening, the qualification and occupational questions did not appear on the screen. Instead, applicants had to print the instructions and questions contained within the vacancy announcement and then use the Web application to enter response options (A-G) into numbered data-entry answer boxes. The announcement also provided information for application by telephone or hard copy. In hard copy format, the mathematical

statistician vacancy announcement and application form was 22 pages long, the statistician announcement 25 pages and the computer specialist was 24 pages. The new hiring system was phased in for mathematical statisticians, statisticians, and computer specialists during August and September of 1997.

Because the occupational questions were new, Census Bureau staff conducted four concurrent cognitive interviews to fine tune the wording and instructions prior to activating the Web system. These interviews were conducted with newly hired Census Bureau employees. Three of the respondents were instructed to complete the application process using the paper format while one was instructed to apply using the generic Web application. Results from these tests were twofold. First, there were cognitive problems with the qualification questions. Respondents misinterpreted the qualifying questions such that they frequently over or under-qualified themselves and incorrectly skipped questions that should have been answered. Second, the cognitive interview that incorporated usability testing revealed many navigational problems with the Web application. These problems were later confirmed by a larger expert review conducted by internal Census staff. The multiple tasks of downloading a paper vacancy announcement, deciphering 22 pages of instructions and questions, pre-filling answers to the occupational questions, and then connecting back on-line to complete the generic data entry template proved to be error-prone, time-consuming, and somewhat frustrating. These problems stemmed from several factors including a confusing sequence of questions, the lack of instructions and questions on the Web application, and the overwhelming amount of information contained in the paper vacancy announcement. We realized that the straight transition from a generic paper form to a Web application was not seamless and that the task of responding electronically was much more convoluted than the old paper version upon which it had been based. In short, the use of high-technology was failing because it had not been properly designed and tested for usability prior to implementation. Due to time constraints, changes could not be made to the Web applications prior to their initial posting on the OPM Website.

The Redesign

In September of 1997, a redesign team consisting of staff from OPM and the Census Bureau started meeting to revamp the on-line Web application, the vacancy announcements, and qualifying questions for all three job series. The team consisted of HTML programmers, questionnaire designers, personnel experts, OPM classification specialists and data processing staff. The goal of the team was to incorporate user-oriented design principles into the application. Specifically, we wanted to create a questionnaire that was easy and straightforward for applicants, one that could be customized to a particular job opening and completed without paper. One of the first steps toward simplification was to eliminate the telephone data entry (TDE) option. Approximately six weeks after the move to the initial Web system, not a single applicant had used TDE to apply for any of the three job series. By eliminating this option, we eliminated the need for two sets of instructions, reduced the vacancy announcement by four pages, and ultimately allowed the process to be completed without paper.

Results from the four early cognitive tests indicated that participants had a great deal of trouble interpreting the qualification questions. The questionnaire designers worked with the personnel and classification specialists to streamline the questions and break them up into smaller component parts. This resulted in a longer series of yes/no questions (as opposed to a shorter series of long questions consisting of up to nine non-mutually exclusive response categories). To avoid the navigational confusion brought about by the original question ordering from the generic bubble form, the designers next reordered the questions such that all demographic information (name, address, veteran's preference, background information, etc.) were positioned at the beginning of the questionnaire while the qualification and occupational questions were placed near the end.

Simultaneous to these text revisions, the HTML programmers designed a new prototype of the electronic application. The first prototype contained a menu frame, questionnaire text to accompany each item, and various response category functions (e.g., radio buttons, pull down lists, and pick lists). In order to accommodate the greatest number of users, the USAJOB site limits its applications to forms that can be processed by an HTML browser 2.0 or higher. Consequently, the programmers could not build in interactive edits for mandatory questions. Instead, 'must enter' edits were processed in the back-end once the application was submitted. The questionnaire designers also added instructional text after sets of questions to provide feedback at each step of the qualifying section since automatic branching functions could not be supported in an HTML form.

Once the qualifying questions were revised and the new prototype was designed, we conducted iterative usability tests that incorporated a 'think-aloud' protocol. We conducted these to test comprehension of the revised qualification questions, instructions, navigational functions, and response formats. Each participant was asked to complete an application on-line. They were observed and video-taped as they worked their way through the task. The video projected a picture-in-picture image of the participant and a scan-converted image of the navigational activities illustrated on the monitor.

As participants worked on the task, we conducted a concurrent cognitive interview by probing and encouraging the participant to verbalize his/her thought processes as he/she read the vacancy announcement, accessed the Internet, and attempted to complete the electronic form. This method allowed us to analyze not only the questionnaire wordings and instructions but also the layout and navigation of the form (e.g., menus, frames, pick lists, text placement, mouse clicks, scroll bars, etc.). Quantitative metrics such as task timing were not implemented since we used this interviewing method. Participants for our tests included newly hired Census Bureau employees, students at a nearby university, and employees in private-industry statistical organizations with occupations similar to those we were testing.

The tests were conducted in a series of rounds primarily conducted at the Census Bureau's cognitive lab facility. During the first round of testing for the mathematical statistician questionnaire, we conducted three interviews. We quickly summarized, documented and communicated our recommendations to the programmers. Once the programmers implemented the recommended changes, a second round of testing followed with three new participants. To further speed and facilitate the usability findings, the programmers observed

at least a portion of the usability tests. We next conducted a single-round series of tests for the other two job series since the CSAQ layout and functionality was similar across the three applications. In all, we conducted a total of 12 usability tests for the three on-line instruments.

Findings

Our test recommendations are based more on qualitative than quantitative measures since the concurrent interviewing technique impedes a clean interpretation of timing and other user metrics. Nonetheless, we believe that several findings may be valuable to Web forms design in general. One of our first findings involves the use of a table of contents or menu frame. Because of the form's length, we suspected that users might prefer some means for browsing or reviewing the form before trying to complete it. To accommodate this, the initial redesign divided the screen into two parts. To the left was a framed table of contents which contained links to various parts of the form identified by topic area (e.g., Name, Address, Computer Skills, Statistical Concepts and Methods, etc.). This enables users to click on the links as a way to move between different parts of the questionnaire. The right part of the screen contained the question and answer categories with a standard vertical scroll bar as a means of progressing linearly through the questionnaire (see Figure A).

Contrary to our suspicions, the testing revealed that the table of contents was not the primary means of navigation. Two of the participants consulted it only to look for a 'help' button. Another participant only noticed it after finishing the form. A third used it at the beginning but quickly opted for the scroll bar as a means of navigation instead. In fact, all of the participants in the early round of testing tended to use the vertical scroll bar as a means of moving through the form. However, our tests did not include an assessment of *preference* for a menu, so we could only gauge actual *usage*. This was somewhat unfortunate considering a previous Census study that did include a preference assessment concluded that while most participants do not use the menu, they overwhelming preferred the design that contained one (Sweet, et. al. 1997). It would have been interesting to see if these findings were replicated for the OPM interface. Since the table of contents was not heavily utilized and required some Internet browsers above the 2.0 OPM standard (in order to support frames), we decided to remove it from the application. This decision sparked some internal discussion since it violated what some consider to be conventional Web design (Shneiderman, 1998). However, Schneiderman points out that links or menus may not be necessary if users are expected to read text sequentially. Since this is typically the case in a CSAQ, it may explain why the menu was not used.

A second design concern was navigation when the answer categories scroll off-screen. This occurred when a set of questions using the same response categories were long enough to take up the entire screen. As participants answered questions and moved forward, the response categories were pushed up and out of sight. Our programmers anticipated this problem and built in a potential solution involving key 'flyovers'. An extra 'key' column next to the response columns (A-G) contained hyperlinks designated as 'A', 'B', etc. If the participant moved the mouse over a hyperlink, the corresponding response category appeared in a narrow yellow frame at the bottom of the screen, e.g., if the mouse was on the 'B' key, the text 'I have had no education or experience in this' appeared within this frame (see Figure A).

Again, contrary to our suspicions, the tests suggested the flyover feature was not helpful. Most participants didn't notice the feature, and those who did notice were unable to make the connection between the mouse positioning and the text appearing at the bottom of the screen. More typically, participants clicked on the hyperlink, a typical learned Web convention, which jumped them back up to the original set of response options. This was not what users expected. The most common navigation convention was to memorize a subset of the response categories most likely to be selected, answer several questions, and then scroll up periodically to verify meanings. While this isn't the most efficient navigation procedure, it appears to be the most natural for users in this situation. As a result, we removed the flyover key feature and instead repeated response sets throughout the form where the list of items was long enough to scroll them out of view.

Another cause for concern was the length of the questionnaires. To reduce user burden, we wanted to provide early feedback to unqualified applicants so they weren't burdened with completing the entire questionnaire. Although the vacancy announcement explains the qualifications for each grade level, we suspected that users do not typically refer to it while completing the on-line form (this behavior was confirmed in the usability tests). Since we could not provide immediate feedback via interactive edits, we placed simple statements beside response categories that identify unqualified applicants. For example, if an applicant selected 'no' to the question determining minimum hours of required mathematics and statistics, they would see 'stop, you don't qualify' next to the response option. Although the intent of these instructions was to *decrease* the number of unqualified applicants, it could also theoretically *increase* the number of unqualified applicants by letting users know the 'correct' sequence of answers necessary to meet the minimum qualifications. We examine the ramifications of these instructions in the last section of the paper.

In addition to respondent burden, the questionnaire length presented a technical problem. Data processing staff became concerned that the size would preclude older browsers from successfully loading and viewing the questionnaires. System testing proved their assumption was correct for two of the three questionnaires. We decided to split each of these questionnaires into two Web pages of relatively equal size. A number of issues came up with this decision: namely, how do we inform applicants how long the questionnaire is, when do we send data to the server, and when should we return edit feedback for mandatory items? We decided to inform applicants of the questionnaire length at the bottom of the first page and the top of the second page. The bottom of the first page stated, "To send questions 1-x: Press the Continue button. Please be patient." At the top of the second page we added, "To finish the application answer these questions and click on the submit button at the bottom of the form."

With the instrument now split in two, the placement of edit feedback for mandatory items became tricky. Back-end processing made it necessary to run the edits after each page was submitted, thus all edit failures from the first page appeared immediately after the page was submitted. Users were then prompted to correct their errors and resubmit the page. All

errors had to be corrected before the application would continue to the second page of questions. This "correct before proceeding" seems to be common in current HTML Web CSAQ design, particularly those using built-in skip capabilities (see http://www.pulsetr.co.uk/demo; www.harrispollonline.com; www.surveycraft.com). Because we only split the application into two pages, respondents were allowed to complete a great many questions before any edit failures were returned, thus minimizing the interruptions and wait time. The Web survey URLs cited above are broken up by both edit feedback and page breaks with much greater frequency.

Another finding deals with the design of questions prone to item nonresponse. We noticed during testing that the Veteran's Preference question was skipped by many participants who assumed it didn't apply because they weren't claiming any preference. They read the question, but never accessed the answer categories which were in a drop down list. A 'no preference' option was available in the 'click to pick' drop down list, but they never saw it. Since this question was mandatory and would result in an edit failure if left blank, we decided to make 'no preference' show up as the default in the response window. We recommend that Web designers consider this tactic in similar situations, but implement with caution since it is not best practice to presume answers. Our last generalized finding deals with the choice of using either pick lists or radio buttons to format response options. Because pick lists can contain many response options within a single window, they have the advantage of taking up less space, making the form appear shorter. However, users must click on the drop arrow, move the mouse to the desired category and then click again to select the desired response. On the other hand, radio buttons display all response options together without any user action other than a single click next to the desired response. In our initial prototype we used pick lists for a series of questions for which the answer was either 'I have done this' or 'I have not done this'. Our usability tests suggested some respondents grew weary of using pick lists to select between only two categories. Consequently, we altered the design to radio buttons for this battery of questions. Although we have no quantitative evidence to support it, we suggest a rule-of-thumb that questions with five or less response options use radio buttons over pick lists. (This assumes the five or fewer response options are succinct).

Implementation and Results of the Redesign

In late January 1998, the revised vacancy announcement and redesigned custom on-line applications replaced the old announcements and generic Web application. The new vacancy announcement for mathematical statisticians was reduced from 22 pages to 13; the statistician announcement from 25 pages to 13 and the computer specialist from 24 pages to 14. All three announcements were posted in HTML on the USAJOBS site and contained instructions for electronic application (including a direct hyperlink to the appropriate on-line questionnaire) and instructions for a hard copy version. Because the new announcements all contain direct links to the on-line questionnaires, the electronic application is paperless -- one of the redesign team's primary goals.

In order to evaluate some of the changes made to the qualifying questions, we utilized data from the OPM. As part of standard operating procedure, every on-line OPM application undergoes a clerical review to confirm the accuracy of the self-assessed qualifying questions. Answers to the questions that determine grade-level eligibility are examined to make certain they agree with information contained within the applicant's resumes, transcripts, etc. If the supporting documentation does *not* agree with the answers given (or if any of the questions have been left unanswered), then the answers are modified. These modifications yield several possible outcomes: ineligible for the position, a decrease in grade level eligibility, an increase in grade level eligibility, or no change to eligibility. OPM agreed to provide outcome tallies from these reviews for the month just *prior* to the redesigned Web application and then again for a six-week period immediately *after* the new application was activated. This yielded 96 cases from the old Web application and 184 from the redesigned version. Our analysis only examined applications submitted via the Web. Very few hard copy applications were received once the new Web version was activated (less then 3% of all applications). Consequently, self-selection bias was not much of a concern in our analysis. Results from these reports provide an indication of how well the changes to the qualifying questions worked.

In the original Web questionnaire, discrepancies were discovered for one or more of the qualifying questions in almost half of the cases surveyed (48%). In the customized questionnaire, this percentage was decreased to 40% but not enough to be statistically significant (chi-square=1.07, d.f.=1, $p>.10$). Obviously, we were disappointed by the lack of significant improvement in this area. The largest improvement was seen in the computer specialist questionnaire where the percentage of cases with answer changes dropped from 64% to 42%.

We next examined the outcome distribution for those cases where discrepancies were discovered. Because of the built-in edits in the revised system, the percentage of cases requiring modification due to item nonresponse (missing data) dropped from 26% to 0%. The most common result from a discrepancy was a decrease in grade qualification or a switch to an ineligible rating. The latter finding caused us wonder whether the user feedback placed next to the qualifying questions had encouraged applicants to exaggerate their credentials by making obvious the 'correct' answers required to minimally qualify. OPM confirmed that in a small number of instances, applicants were claiming coursework or degrees they simply did not have. However, for the majority of cases they reported that respondents had honestly misinterpreted the coursework requirements (e.g., counting Business Calculus I as an 'advanced math' course). Additionally, OPM reported that there was not a single applicant (to date of this writing) who submitted a questionnaire with answers self-identifying themselves as *not qualified* according to the instructions beside the qualifying questions. We surmise from this that the instructions worked as intended at least for users who started the application but then realized they did not qualify.Our final analysis examined the new qualifying questions on a micro level in order to better explore the question meanings. Frequently, survey methodologists are limited to evaluation measures such as item nonresponse which yield information primarily about questionnaire navigation. The OPM document review provided a rare opportunity to assess the respondent's *comprehension* of the questions by comparing self-assessed answers against written documentation and official records.

Our examination revealed an interesting pattern:

discrepancies were observed more often for the descriptive 'work experience' questions than the education or government service questions. The work experience questions contained lengthy descriptions of job duties as a way to equate civilian job experience with a formal government grade level. The wording for these descriptions were derived directly from the OPM classification standards and were not modified as a result of our 'think-aloud' interviews. Perhaps because of this, our finding is not so surprising. Many respondents in the usability tests had difficulty distinguishing differences between the progressively higher work experience descriptions and often assessed themselves at a higher level than was actually warranted. Part of the problem stems from the vague statements and minor wording differences that comprise the hierarchy of standards. For example, part of the grade 9 statistician work experience reads 'applies statistical theories, techniques, and methods to analyze data' while a grade 11 description for the same series reads 'selects and modifies statistical techniques and methods to produce and analyze data.' Unfortunately, our redesign schedule did not allow the luxury of further cognitive testing and modification to these complex descriptions. As a result, the different qualification levels were hard to distinguish and misinterpreted by many respondents.

Conclusions

Findings from our case study reinforced the notion that iterative usability testing is essential before migrating a paper questionnaire to a Web-based survey. We learned several findings from usability testing that, while not necessarily backed by empirical research, tend to address some common questionnaire design issues facing Web survey methodologists. First, we discovered that menu frames were not widely utilized as a means of questionnaire navigation -- scroll bars were the preferred method for our questionnaire containing few page breaks. Second, one way to decrease item nonresponse and reduce edit failures is to program 'not applicable' as the default entry in 'click to pick' lists. This is recommended with caution and only for questions known to be frequently skipped because they do not apply and in cases where automated branching and skips cannot be programmed. Third, when a question contains five or fewer response options, we recommend using radio buttons (or check boxes when multiple responses are allowed) instead of pick lists. These interface elements take up more space, but require fewer user manipulations. Finally, we recommend that the flow of the questionnaire be maintained and task completion be uninterrupted as much as possible by breaking the questionnaire into the least number of pages necessary to accommodate older browsers. This not only decreases wait time between questions but also minimizes the 'correct before proceeding' convention by returning edit failures in groups rather than one at a time.

NOTE: This paper reports the results of research and analysis undertaken by Census Bureau staff. It has undergone a more limited review than official Census Bureau publications. This report is released to inform interested parties of research and to encourage discussion.

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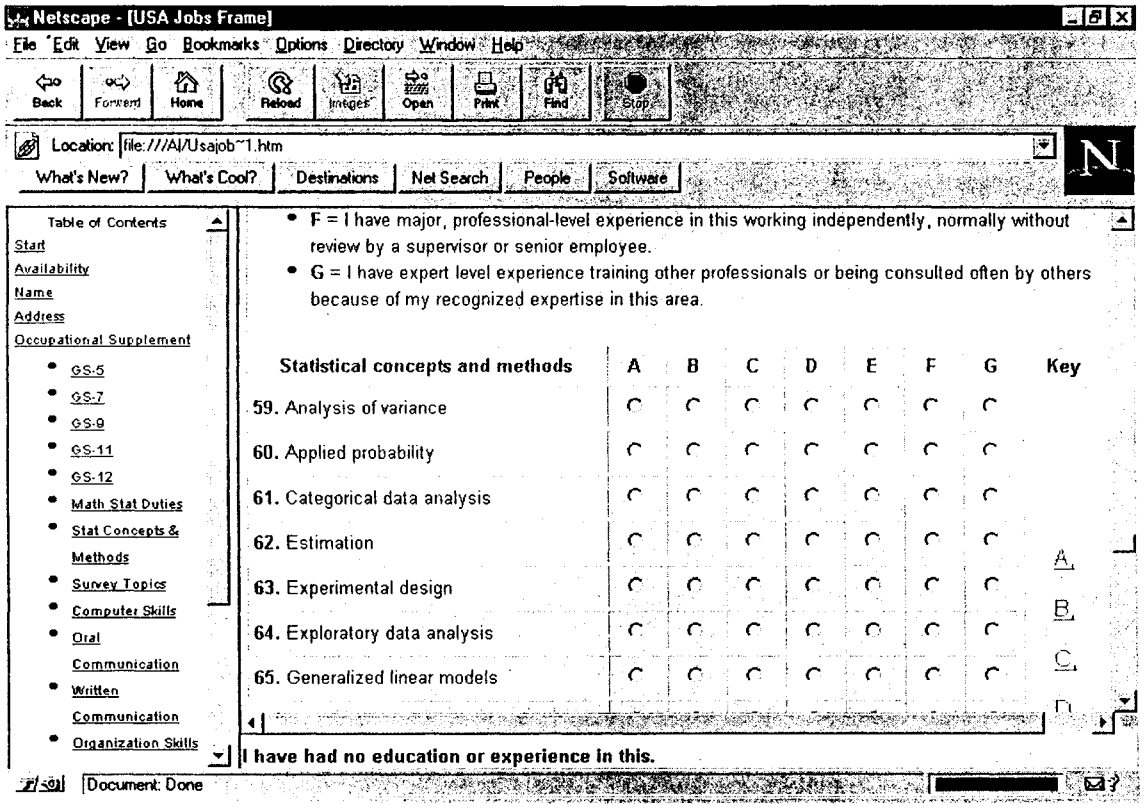
Figure A.


Netscape - [USA Jobs Frame]
File Edit View Go Bookmarks Options Directory Window Help
Back Forward Home Reload Images Open Print Find Stop
Location: file:///A|/Usajob~1.htm
What's New? What's Cool? Destinations Net Search People Software
Table of Contents
Start
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Math Stat Duties
Stat Concepts & Methods
Survey Topics
Computer Skills
Oral Communication
Written Communication
Organization Skills
• F = I have major, professional-level experience in this working independently, normally without review by a supervisor or senior employee.
• G = I have expert level experience training other professionals or being consulted often by others because of my recognized expertise in this area.
Statistical concepts and methods A B C D E F G Key
59. Analysis of variance
60. Applied probability
61. Categorical data analysis
62. Estimation
63. Experimental design
64. Exploratory data analysis
65. Generalized linear models
A
B
C
I have had no education or experience in this.
Document: Done