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Comparability and Usability: Key issues in the design of internet forms for New Zealand's 2006 Census of Populations and Dwellings

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Designing internet questionnaires to collect data that will ultimately be comparable with the data collected from paper questionnaires can present a number of challenges for developers. This paper discusses the design and development of internet forms for use in a mixed-mode Census in New Zealand in 2006. Using experiences from the design and testing of prototype forms, it describes design features intended to take full advantage of the capabilities of the internet mode, while preserving the qualities of paper based responding to help prevent mode effects. The discussion highlights the role of usability testing as a key tool in evaluating the success of those design strategies and ensuring that the forms would be simple and easy to use.
Keywords: Questionnaire design, On-line forms, Internet survey, Mode effects, Usability, Census

Introduction

The internet is rapidly gaining popularity and credibility as a means for collecting survey data. Survey researchers recognise the potential efficiencies and cost savings that this technology can offer in an environment where response rates are dropping (de Leeuw 2005) and data collection is becoming increasingly difficult and costly.

National statistical agencies, like other data collectors, are looking for ways in which internet surveying can be incorporated into their standard collection practises. Many national agencies already use the internet to collect data for business surveys (see for example `http://www.unece.org/stats/documents/2002.02.edr.htm`). However, there are fewer cases where the internet has been used to collect social data (de Leeuw and de Heer 2002).

However, Statistics New Zealand, like a number of national statistical agencies around the world, elected to include an internet option for its recent population census. Participation in Census is compulsory in New Zealand and by offering respondents a range of ways to complete their census form, Statistics New Zealand hope to encourage compliance by providing greater flexibility and convenience for respondents.

However, converting a paper questionnaire into a web based questionnaire, to retain data comparability between internet and paper-based responses, is a challenging task for survey designers. Even minor changes in the layout and formatting of questions between modes can convey different expectations about the kinds of information required (Tourangeau, Rips and Ransinski 2000). This makes it particularly important for designers to consider the layout and design of the forms at the very start of development, so that questions are presented in an equivalent format in both modes. This kind of approach has been described by Dillman (2000) as uni-mode construction.

Usability issues are also important to consider in the design of internet forms, as the task of responding to an internet questionnaire differs in significant ways from the task of responding on paper. Respondents face additional cognitive demands, which mean that their attention can be divided between the question answering task and the actions required to perform that task on their computer (Hansen and Couper 2004). Therefore, alongside other methods of testing used to evaluate questionnaires (see for example, Biemer and Lyberg 2003), usability testing is a further stage to consider in designing internet forms.

The following discussion focuses on some of the issues encountered in building and testing prototype forms in preparation for New Zealand's most recent Census of Population and Dwellings, undertaken in 2006.

Background

In New Zealand, census information is collected using two paper forms, an 'Individual form' and a 'Dwelling form'. These forms are delivered to every occupied household by enumerators employed for the task. There are two variants of these forms, English-only and bilingual. In the bilingual version the Maori language (New Zealand's second official language) is presented alongside English, on opposite pages.

The Census of Population and Dwellings in New Zealand is conducted once every five years. It is the primary source of information on the size, composition, distribution, economic activities and state of wellbeing of the population. As a key and critical information source, data users need to feel assured that changes they see in data for 2006 will reflect a real change in the environment, and will not simply be the result of the different modes that were used to collect data.

One of the primary objectives of the current development

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was to attempt to minimise mode effects so that there would be no major differences between the data collected from internet respondents and paper respondents. Designers aimed to make the task of filling in forms on the internet as similar as possible to the task required on paper, while also taking advantage of the main benefits that the internet mode had to offer.

A second and equally important objective for the development was to ensure that forms were easy and simple to use. Usability testing was therefore seen as a key component of the development cycle as a way to ensure that designers developed a 'user-oriented web questionnaire' (Murphy 2002).

Prototype Development

To help inform the development of an internet option for the 2006 Census, Statistics New Zealand's development team began by designing and building a working prototype system in-house. This approach meant that design choices could be fully assessed and improvements introduced through an iterative process of usability testing and revision.

Development of this prototype system began in September 2002 in preparation for a small field test in June 2004. Work was undertaken by a small design team of two questionnaire designers and a computer programmer. This team worked alongside several other questionnaire designers responsible for developing the paper based census forms.

Because the prototype system was only a small scale version of a much larger system required for the dress rehearsal and final census, an additional team of three to four business analysts were also engaged in concurrently planning and designing the security, architecture and infrastructure required for the ultimate census site.

However, by building a small scale prototype initially, designers hoped to evaluate the usability of the proposed design and ensure that costly mistakes were avoided.

Most early design choices were based on general principles for designing internet questionnaires, drawn together from a review of the literature, work done by other agencies overseas and Statistics New Zealand's own standard guidelines for electronic developments. During the design phase, developers were cognisant of the key objectives for the project, and in particular the need to try and minimise mode effects. This was a major influence in many of the design choices that were made.

During the second phase of the project, the team began usability testing. This testing phase provided the opportunity for designers to refine and further enhance original designs in order to maximise usability.

Usability testing is a widely used term which can encompass a range of methods and techniques (Hansen and Couper 2004). This particular research was qualitative in nature and employed usability techniques commonly described as end-user evaluations. As such, this work involved observing and debriefing users actually engaged in using and interacting with the system and aimed to identify any problems with the design. Although end-user evaluations are commonly undertaken in a laboratory setting, for this research tests were conducted in respondents' own homes, using their home PC, to provide a more natural setting. Interviewers borrowed techniques from 'cognitive testing' such as concurrent probing, retrospective probing and think-aloud to gain an insight into the ways that respondents were interpreting and responding to the information presented on screen.

The testing was an iterative process using a relatively small sample of users, where designers could evaluate and make revisions to the system after just a few tests, before testing again. This iterative process of testing early and often makes the user the central consideration in the design of the system-user interface (Murphy 2002) and helps ensure that all major problems are identified and corrected.

For this development information was collected about the ease and accuracy with which users from a wide range of backgrounds and with various levels of computer literacy, were able to understand instructions, fill out the census forms and carry out specific tasks. This allowed developers to compare several alternatives in presenting information on the screen and to identify the optimal design for the greatest number of users. In particular, testers looked to see how well users were able to navigate through the system, enter data correctly and access help and additional information when required.

In total, there were sixty tests conducted between February and July 2004. Forty-four of those usability tests were conducted using the English version of the forms and another 16 used the Maori versions. Purposive sampling techniques were used for this research, and respondents were selected to include both male and female respondents, from a range of age groups and ethnic backgrounds. In particular, the sample was selected to include respondents with varying degrees of computer competence, ranging from virtual novices to regular users.

Tests took approximately one to one and a half hours to complete and most were conducted in respondents' homes using their own computers. However, a small number of interviews were conducted at the offices of Statistics New Zealand. All respondents were required to access the internet forms at a website address printed on a paper slip and complete both a 'dwelling' and 'individual' form. During each test an interviewer sat next to the respondent to observe. The interviewer asked follow-up questions when this task was completed, and took comprehensive notes throughout the interview to record the results.

Form designs was altered and revised, based on findings, throughout the testing phase.

Design Features

As stated earlier, the two key aims of the internet development were to design a form which:

- was capable of collecting data that would be comparable to the data collected from paper forms
- would be simple and easy to use for the widest possible range of respondents

To meet these objectives, a number of design features and strategies were developed. Some of the key features of that design are discussed in the following sections.

It should be acknowledged that many of the features described in this paper require java script to be enabled on a respondent's computer. Figures suggest that 94% of users worldwide have java script enabled (for example, w3schools). However, for users' without this functionality, plain html forms were also developed. The development of these html forms is not discussed here.

Simple Design

Research on website design consistently recommends simplicity (for example, Neilson 2000, Dillman, Tortora and Bowker 1998). With this principle in mind, designers took a conservative approach to the design in order to make the option usable to the largest number of respondents and not just those that were 'technically sophisticated'.

Text on system screens was also displayed in a simple and easy to read format. For example, links were critical to the user's success in navigating through the system and were presented as stand alone text, rather than embedded into paragraphs with surrounding information. Usability research suggests that this format increases the visibility of the links and helps facilitate easy navigation throughout the site (Spool, Scanlon, Schroeder, Snyder and DeAngelo 1999).

Where a number of links were presented together on the same page, they were generally presented in a simple single column list. Labels on those links were written to be as clear and descriptive as possible to further facilitate navigation by ensuring that users could accurately predict where the link would take them.

Testing indicated that this presentation was effective, as users had very little trouble navigating through the site. Almost all users were able to identify the links they required and follow the path, through several pages, to reach the forms. Navigation was generally very quick and observations of users' reading behaviour confirmed that users would typically skim headings and key phrases rather than read large blocks of text. This supported other usability findings which suggest that reading from a screen differs in important ways from reading text on paper (Spool et al. 1999).

Logging-in

An essential task in enabling users to successfully fill in a census form online was to design a page that made it easy for users to understand and complete a two step log-in process to authenticate their identity. Because of the critical nature of this process, the design of the log-in page was given careful attention during development, and testing focused heavily on the usability of this page.

To log-in on census night users needed to enter an 11 digit identification (ID) number from the paper form delivered to their household and a 12 digit Personal Identification Number (PIN) from a sealed envelope accompanying the forms. An initial concern was that some users might have difficulty entering these long strings of numbers correctly. To help optimise number recall and prevent log-in problems, both the ID and PIN numbers were printed on reference documents in parsed groupings of three to four characters. The fields presented on the log-in page were designed to mirror this presentation. In addition, the ID number was split over four different rows, to correspond with the layout on the paper forms.

However, testing elsewhere indicates that a more common problem is that users can have difficulty locating numbers on source documents (Murphy 2002). To assist users with this task, a graphic was included on screen to illustrate the position where the ID number could be found on printed documents, as shown in Figure 1.

These design strategies appeared to be effective in usability testing and few users experienced problems when logging in. Although simple keying errors were relatively common, none of the users tested during the development required more than three attempts to log-in, and most were successful on their first or second attempt.

In particular, the graphic proved to be very useful in assisting users to locate the ID number on paper reference forms when they required it. Designers therefore felt confident that users would be able to complete the log-in process successfully and no major revisions were made to this page.

Look and feel of paper forms

Because all census respondents received paper forms, even if they elected to respond on the internet, designers felt it was important that users would identify the forms they saw on screen as replicas of the paper forms delivered to their household. Just as paper census forms are designed to have an 'official' appearance, so too were the internet versions.

In order to create an immediate visual connection between paper forms and the internet forms, designers chose colours and fonts which replicated the look and feel on paper.

As illustrated in Figure 2, visual guides were used in a consistent way to paper, with questions presented in bounded regions so that users would have no difficulty identifying individual questions and knowing where each item started and finished. In other words, 'common region' was used to define each question in line with Gestalt's theories on pattern recognition (Jenkins and Dillman 1997).

Question numbers were displayed in the top left hand corner of each question in reverse print and these reverse print numbers were repeated for instructions where users needed to refer back to previous questions. This provided a strong navigational guide for users and replicated the way questions were presented on paper forms.

The comments received during usability testing confirmed that users immediately recognised the forms as similar to the paper versions and felt reassured that they had selected the correct option.

Single scrolling page

An early, although contentious decision during the design phase was that each form should be presented as a single scrollable page, rather than as multiple screen by screen

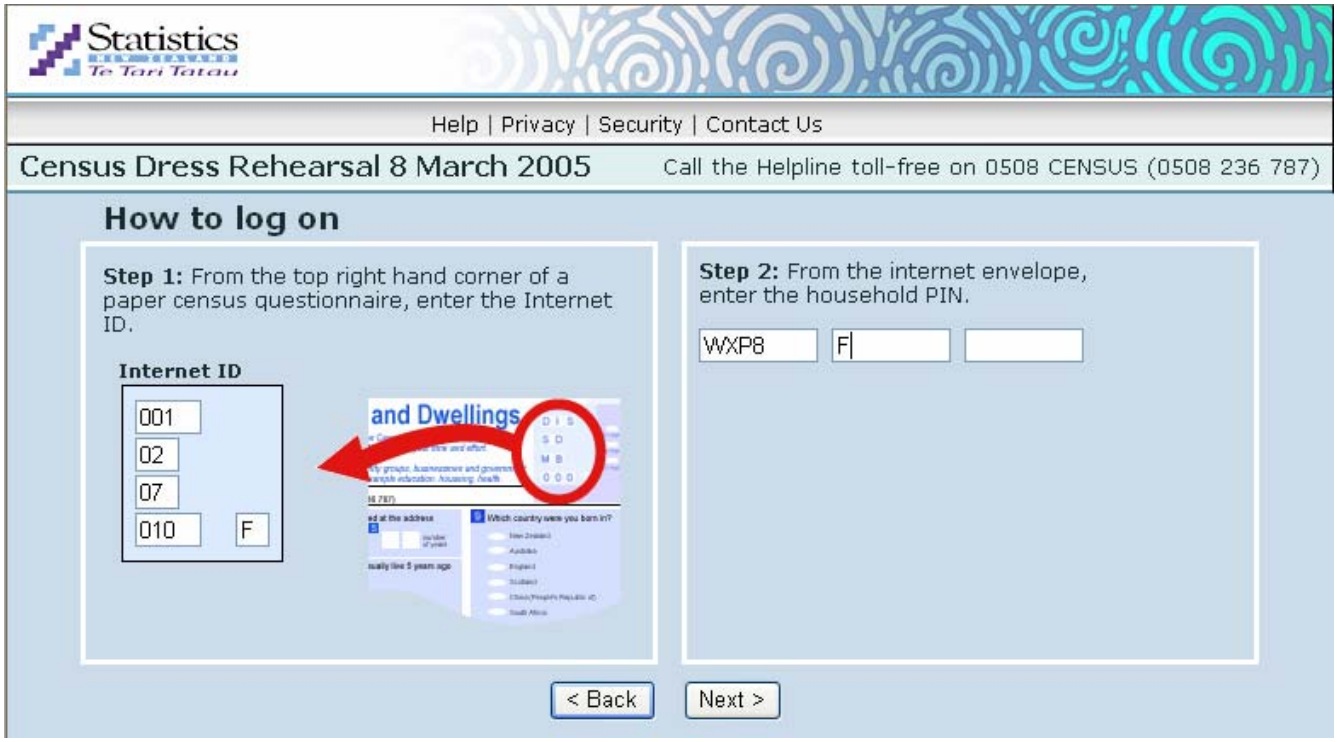

Figure 1. Log-in page

pages. Although there is some discussion about this particular format in the current literature (see for example Dillman 2000, Vehovar, Batagelj and Lozar Manfreda 1999), designers felt that this option provided a context that was most like that of a paper form in allowing users to easily move backward and forward within the questionnaire. With this format users can refer back to earlier parts of the questionnaire and check previous answers to facilitate cognitive processing when there are a series of items related to the same topic.

Although there were reservations about the impact of this choice on form download times and system performance on slow speed internet connections, designers felt that in the census context users would be engaging in a purposeful task (fulfilling a legal obligation to complete a census form) and would therefore be more inclined to wait for forms to download.

However, in opting for the scrolling form approach, designers were also cognisant that each individual question should be viewable on a single screen without scrolling, as research has shown that important information can be missed if it is hidden below the bottom of the screen (or 'beneath the fold') where users need to scroll to see it (Spool et al. 1999).

Testing during the usability phase showed that most users were competent in using the scrollbar to navigate through the forms and many were observed returning to previous questions to re-read and check an earlier understanding.

The scroll bar provided a means for users to gauge their progress through the form and some users also commented that they liked being able to print and retain forms, which was an added benefit of the scrolling design.

However, in testing a small number of users accidentally scrolled past questions without providing an answer. Although these users almost always detected their error, this was a distinct drawback of the scrolling format.

Online Help

One of Dillman's principles for good questionnaire design (2000) is to place directions where they are easily seen and close to where they are needed. In line with that principle, access to online help information was provided through 'help' buttons placed on the lower right of each question frame, as Figure 2 shows. This position was chosen because of its proximity to the scroll bar, where it would be visible to the user if needed, yet was unobtrusive if users did not require help. By placing the buttons in this position, designers hoped to avoid interrupting the user's cognitive processing of the question-answer process unless help was required. This design therefore approximated but improved on the task required on paper, where respondents need to reference help in a separate document or on the back pages of the form when completing a paper questionnaire.

The positioning of help buttons appeared to be successful, and during testing most users were observed accessing and reading help information on at least one occasion.

Figure 2. Look and feel of Internet forms

Automated Routing

One of the clear advantages of the internet mode is the ability to apply interactive features and dynamic functions to help guide users through the form. Given the high error rates associated with skip patterns in conventional questionnaires, the ability to automatically route users past irrelevant questions was a feature which particularly appealed to designers. This functionality provided an opportunity to improve data quality significantly by minimising routing errors and reducing the incidence of item non-response.

To achieve these benefits, designers initially used a dynamic approach to question routing where inapplicable questions 'disappeared' from the screen when certain answers were selected as illustrated in figures 3 and 4.

However, when this approach was tested for usability, results showed that users were sometimes alarmed by the sudden change to the display and often felt "lost" or "displaced" within the form. Users noticed the sudden movement on screen, but did not seem to understand how or why this change had happened. This gave users a sense that they had little control over the form, and many felt uncertain about continuing, sometimes assuming that something had "gone wrong".

To solve this problem designers introduced a 'greying out' approach which borrowed principles developed for page by page formats elsewhere (Murphy 2002). In this design inapplicable questions were retained on the screen, however the background colour of those questions were changed to grey as a way of signalling to users that the questions did not require an answer. A brief explanation of the greying out functionality was also included amongst key instructions which appeared at the top of the forms.

Greying out to signify a selection is unavailable or disabled is a feature used in other computer applications and one that has a familiar meaning to many internet users. However this was a new and novel approach in a scrollable questionnaire form.

A further enhancement to this functionality in later iterations included the introduction of statements, which appeared at the top of greyed out questions, informing users that they did not need to answer the question due to a previous answer. These statements built upon similar statements used in other census internet developments (Australian Bureau of Statistics 2004), and included a reference to the question which had triggered the response. Figure 5 provides an example. Users who read these statements were able to identify the action that had initiated the greying out and conse-

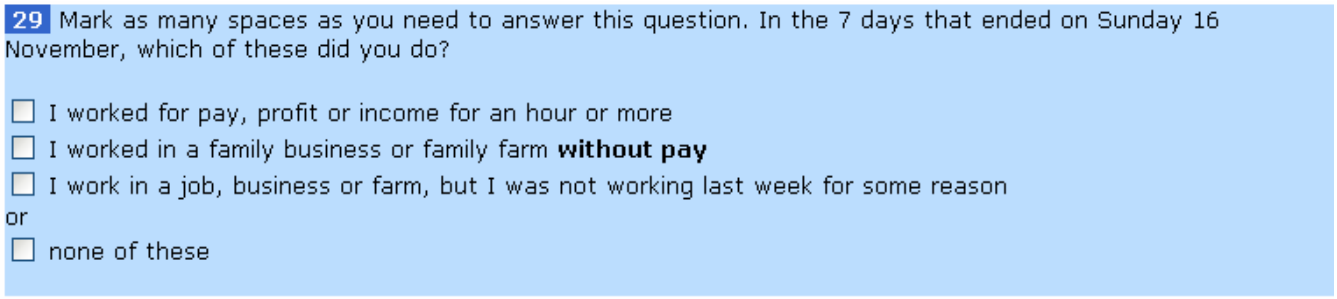

Figure 3. Initial design showing form BEFORE user selects 'none of these' response in Q29, with Q30-Q32 visible on screen

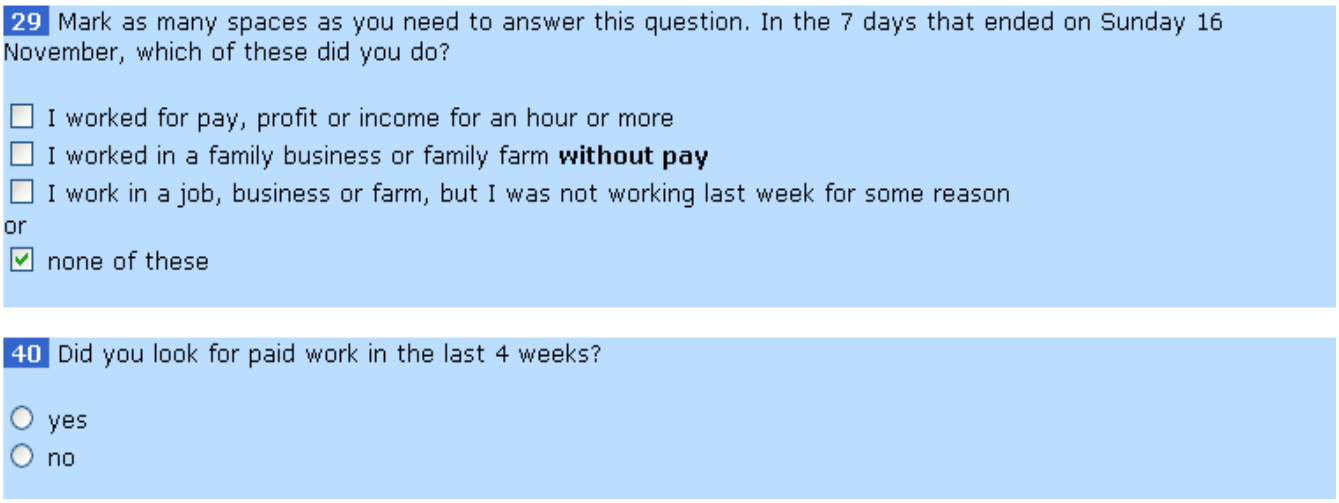

Figure 4. Initial design showing form AFTER user selects 'none of these' response in Q29, with Q30-Q32 no longer visible

quently retained a sense of control over the form. Such statements also gave users the opportunity to check their navigation and return to self-correct an earlier answer if they recognised that they had made a mistake.

Using a similar rationale to that used for the positioning of the help buttons, designers opted to present these statements in grey text so they would be readable if required, yet would also be unobtrusive, so that users' attention would not be diverted from the question and answering task unnecessarily.

Usability testing to evaluate this functionality showed that the design was relatively intuitive to users who were quick to understand that they should scroll past greyed out questions. During the testing exercise some users were inclined to read the greyed out statements and consider their navigation carefully. However, other users, once they had

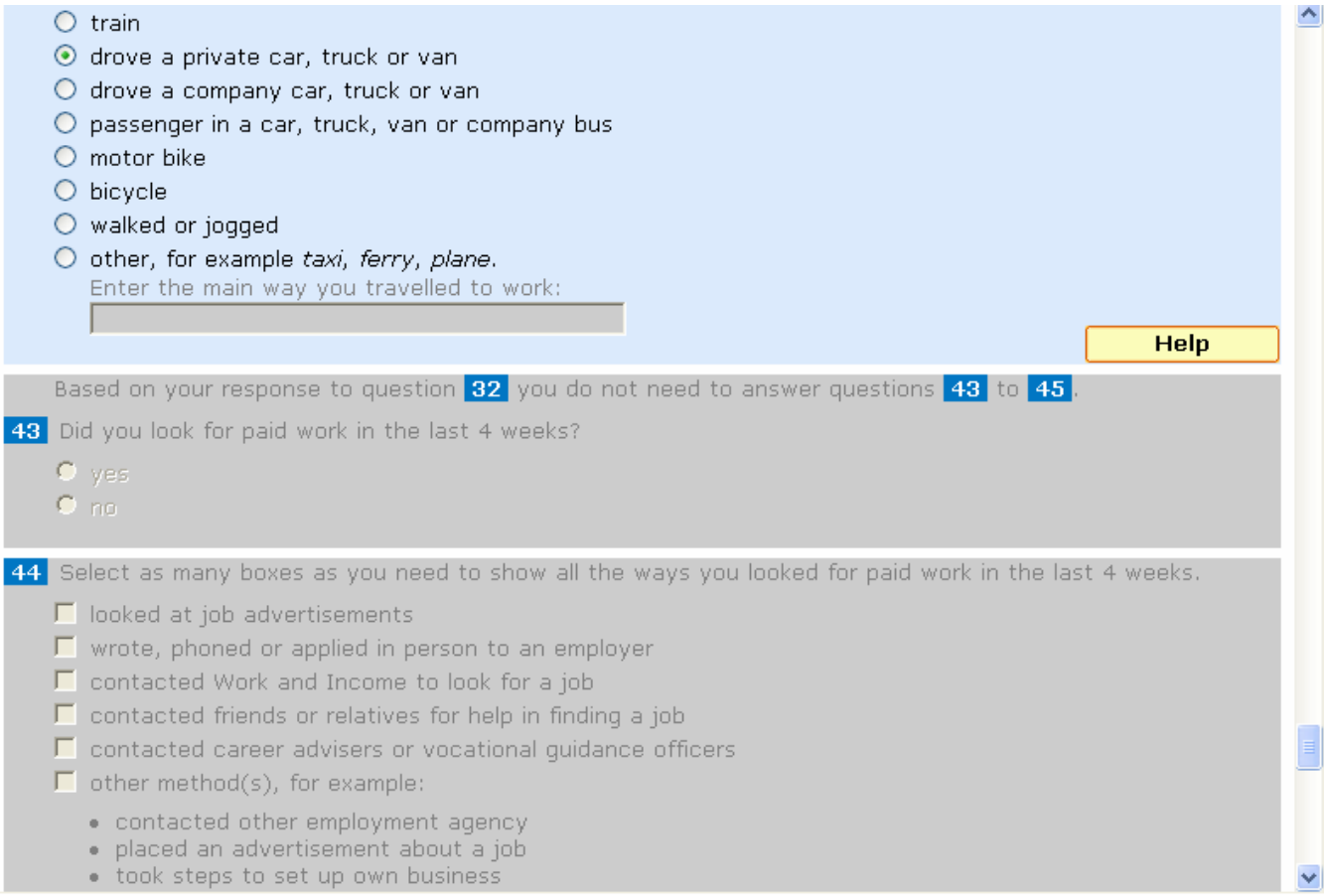

Figure 5. Final design showing 'greying out' of inapplicable questions

understood that greyed out questions were not applicable to them, were quick to simply scroll past those questions without further reading.

However, designers were particularly pleased to see that several users who inadvertently made mistakes during usability testing, were able to detect those errors and successfully go back to correct their answer.

Bilingual design

Another important question for designers, in attempting to reproduce the paper forms in the internet mode, was how to present the Maori language versions of the form. A common approach to presenting information in more than one language is to provide a button or link which, when selected, takes the user to a new page displaying identical information in the language of choice.

However, designers wanted to retain the bilingual nature of the paper form, and provide quick and ready access to translations in English, without the need for users to constantly switch between languages. Access to English translations is known to be important to data quality because those who complete forms in Maori can sometimes have problems understanding questions, due to the formal language used in census. For example, the Maori language equivalents for bureaucratic terminology, such as government schemes and qualifications, are not always well known amongst Maori speakers (Potaka and Cochrane 2003). However, because almost all Maori speakers can also speak English, translations are often useful in assisting the comprehension process.

To achieve this objective a design feature was used where users could 'hover over' a button with their mouse to see an English translation. The advantage of this design was that users would be able to see both languages on screen at the same time to compare questions and check their comprehension of difficult items quickly and easily. By eliminating any need for mouse clicks or additional navigation, it was also more likely that users would refer to translations when required.

The buttons to evoke the 'hover over' translations were positioned prominently, where users would be likely to see them, in the top left hand corner of each question frame, as shown in Figure 6.

Usability testing helped confirm that users were able to find the translations easily. Typically, users discovered the button almost immediately, once forms had loaded. While many read the button and were intentionally seeking out the translation, others discovered the translations unintentionally

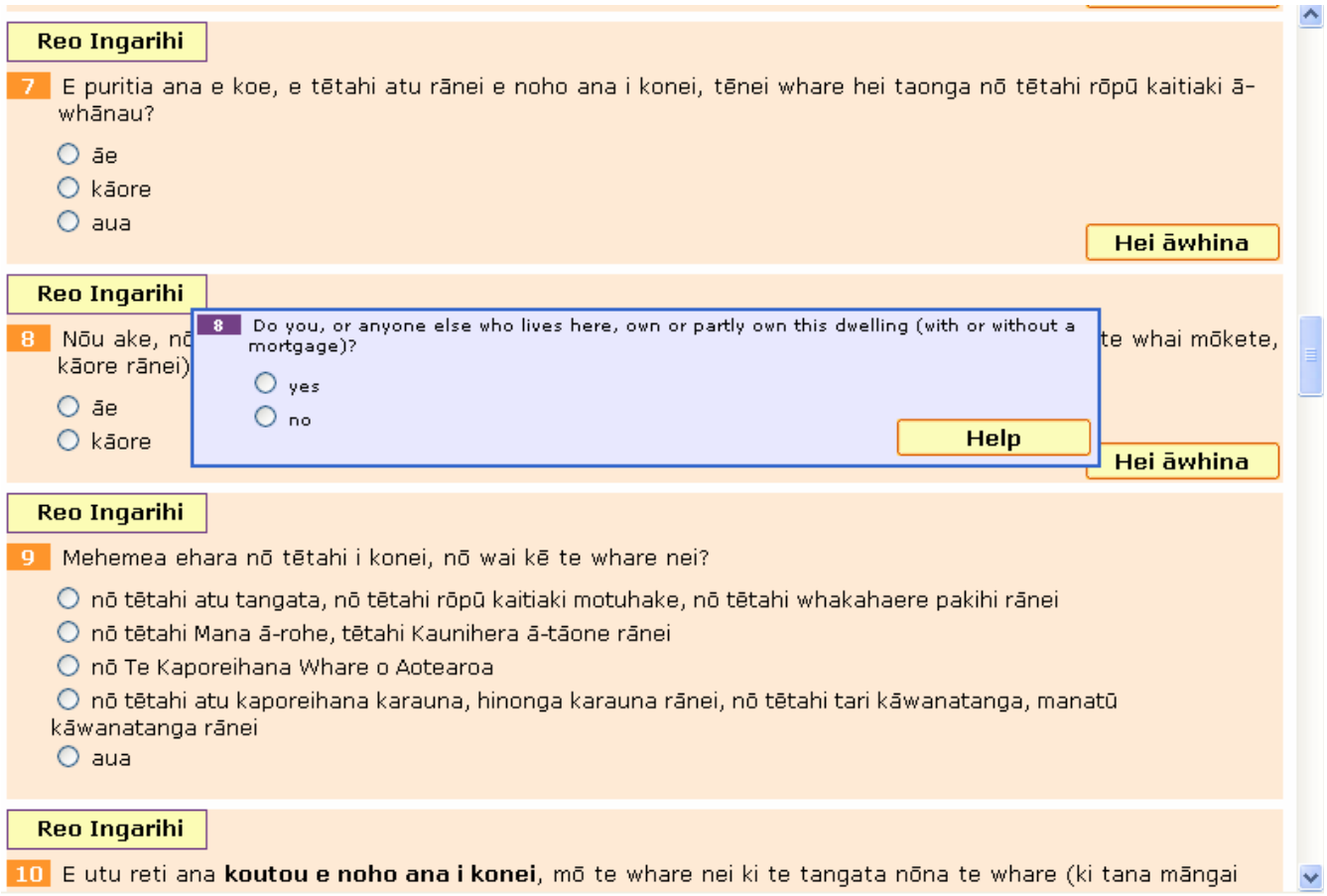

Figure 6. 'Hover over' English translations on Maori language forms

when using their mouse to answer questions.

Although designers were initially concerned that these translations might surprise or annoy users, in testing users were quick to learn that they could remove the translations by repositioning the mouse away from the button. Having located and understood the way that the 'hover over' worked, most users then referred to translations frequently and follow-up comments confirmed that they found them useful.

Checks and Edits

Although the ability to apply automatic edits and cross-checks to validate data is often seen as a distinct advantage of internet questionnaires, the design team were cautious about applying these too liberally. As noted elsewhere (Christian, Dillman and Smyth 2005), a large number of checks and edits can mean that users will become frustrated and abandon forms early. Therefore, this functionality was used sparingly in the design of the internet census forms and the use of automatic checks was largely restricted to critical routing points and non-response of key items, such as name, sex, date of birth and ethnicity.

Designers also encouraged manual checking by including a summary table, displaying users' answers to core questions, at the end of each form. Users were asked to check these answers before submitting their forms. This check resembled the process used for paper forms, where collectors are required to check completed forms on the door-step to ensure that respondents have answered key items.

In the original design of this summary table, users' information was displayed in fields with a white background. Links to take users back to the appropriate question, if they needed to correct their information, were also placed on the right hand side of those fields. However, when testing the usability of this summary table, testers found that users would almost always attempt to edit their information directly within the summary table.

To make it clearer to users that they could not edit the summary table and needed to go back to the question to alter an answer, developers redesigned the summary table. The background colour of the fields in this table was changed to match the background colour of the forms so that fields would not be mistaken as answer spaces. Links were also moved to be placed on the left of the summarised information, as illustrated in Figure 7.

In subsequent testing, when users were asked to go back and alter a particular answer, they were much less likely to

Figure 7. Final design of summary table showing key variables

attempt to edit the summary table directly, and in most cases were inclined to use the links rather than the scrollbar to return to the question.

Conclusion

Examples like those described above illustrate how converting paper questionnaires into the internet mode can present a number of difficult decisions for designers. To make the respondent's task on the internet comparable to the task required on paper, careful thought needs to be given to question layout and dynamic functioning within the form. Taking a 'unimode' approach to the design (Dillman 2000) helps to ensure that respondents perceive an equivalent task in both modes.

In specifying the design of internet forms for New Zealand's 2006 Census, developers found that the construction of prototype forms was pivotal to the success of the project. The ability to see and experiment with screen presentation and functionality was critical in meeting objectives and the opportunity to evaluate aspects of design such as log-in processes, scrolling pages, automatic routing and language presentation, gave developers some confidence that the differences between data collected from paper and the internet would be minimal.

Usability testing was an important and invaluable component of the prototype development. By observing users engaged in the process of answering the census forms, designers could evaluate the success of design strategies, recognise weaknesses and develop improvements. Most importantly testing ensured that users remained the central focus throughout the development, so that internet forms would be simple and easy to use. However, a final step in evaluating the success of these design strategies will be to fully assess the results obtained from the final census in 2006. A full assessment has not yet been completed by Stats NZ.

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