Computer-assisted Self-interviewing over the Web: Criteria for Evaluating Survey Software with Reference to Blaise IS

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1. Introduction

For those in the statistics business, web technologies offer the potential to speed the process of collecting data; to reduce the costs associated with collection and processing, and to make data accessible more widely and more timely. It is not surprising, therefore, that national statistical institutes (NSIs), such as the Office for National Statistics (ONS), are racing to embrace the Internet to enhance the service they deliver to government, other customers and to citizens. This is the business imperative. In addition, governments have added political impetus. For example, in the United Kingdom (UK) central government has set a target for all public services to be available on-line by 2005. Similar, but more ambitious, targets have been set in Australia (2001) and Canada (2004). As the number with Internet access grows and people become accustomed to using it, there is likely to be increasing demand from the providers and users of official statistics to use the web for such purposes.

Social Survey Division (SSD) of the ONS is examining the feasibility of using the web for the surveys that it undertakes. Nationally representative surveys of the private household population carried out on behalf of the ONS or other government departments, forms the core business of SSD. Such surveys employ random probability sample designs and are voluntary. SSD surveys tend to be undertaken by trained interviewers using computer assisted interviewing (CAI). Computer assisted personal interviewing (CAPI) is often the single mode of data collection. There are examples of surveys that combine CAPI with another mode. For example, the Labour Force Survey (LFS), which is a panel survey, uses CAPI for first interview and offers a computer assisted telephone interviewing (CATI) option for subsequent interviews (there are five interviews in total). On both the Expenditure and Food Survey (EFS) and National Travel Survey (NTS), following an initial CAPI interview, respondents are asked to self-complete a paper diary. SSD is also commissioned to sample other populations, such as school pupils, in which paper and pencil interviewing continues to have a role. Interest in using the web for such surveys may increase.

The challenge of the Internet

The characteristics of government social surveys of the general population do not readily lend themselves to web data collection. Social surveys of the private household population tend to have the following requirements:

- random probability sampling
- long and complex questionnaires, e.g. interviews of 1 hour or more are typical
- high response rates, e.g. 80% plus are a common requirement

These features contrast with common practice on web surveys and raises questions about the potential use of the Internet for general population surveys which are required to yield nationally representative estimates. The absence of an adequate sampling; the fact that the proportion of households with Internet access remains low, and that the on-line population differs in important respects from the general population mean that it is not possible to achieve good population coverage with stand-alone web-surveys.

This suggests that in the immediate future the most likely application of the web in official social surveys is as part of a mixed mode data collection strategy alongside others, such as mail, CAPI or CATI. For general population surveys that have self-completion elements there is growing interest in reporting via the web. Offering a web option for parts of the survey that are currently interviewer-administered raises even more challenging questions, such as related to mode effects and survey response.

SSD has established the Web CASI project to examine the feasibility of using the Internet as a mode of data collection on government social surveys. Work to date has included a review of relevant literature and some initial office testing of Blaise Internet Services, an add-on module of the Blaise survey software package. This paper outlines some of the design and implementation issues faced by developers of web CASI instruments and suggests criteria for the evaluation of survey software.

2. Design and implementation issues

For a survey research organisation a number of the certainties of life in a CAPI and CATI environment come under challenge when we embark upon web CASI. Our users are not trained interviewers familiar with the look and feel of a CAI instrument. Instead, they are members of the public with varying degrees of computer literacy and different expectations, for example, about how to navigate through a form and where to locate key information such as the questions and response categories and any associated instructions or help.

Further, the computing environment in which users will attempt to complete the questionnaire is beyond our control. The environment includes:

- the operating system (e.g. Windows, Macintosh) and its version;
- the web browser (e.g. Internet Explorer, Netscape) and version;
- speed and type of Internet connection.

Thus, a number of design and implementation issues arise in the production of a CASI instrument for use over the Internet. A number of the important ones are discussed below.

Screens and scrolling

There are two main approaches to questionnaire construction that have conventionally been used on web surveys. With a screen-based approach usually one question is displayed on each screen and, each time a respondent answers a particular question, the screen refreshes to display the next question. Scrolling refers to the situation when the whole of the questionnaire is available at one time by allowing the respondent to scroll up and down, using a scroll bar to the right of the screen. The choice of which method to use is often related to the way in which respondents are invited to complete the survey. Screen by screen presentations are often used with on-line surveys where there is the need for continuous contact between the respondent's computer and a web server. Off-line surveys often use a plain HTML (Hypertext Mark-Up Language) form which the respondent is able to download from a website or receive as an email attachment. The pros and cons of on-line and off-line approaches are discussed later. Here we're concerned simply with design issues.

It has been argued that scrolling is more akin to the way in which people use computers and surf the web and for that reason should be preferred (Dillman, 2000). It is true that experienced web users are likely to find a screen by screen presentation more cumbersome. They may also be frustrated if they feel their freedom to navigate is constrained. This may be compounded if the time delay between individual screens refreshing is perceived by respondents to be excessive.

Another advantage of scrolling is that respondents can more easily form a perception of the content and the length of the questionnaire before they begin their task. This makes scrolling more like conventional paper self-completion questionnaires where the respondent can easily flick through the document before answering and can form a judgement about how long it will take them to complete.

For these reasons, Dillman argues that scrolling should be preferred whenever web surveys are being used to replace paper self-completion methods. However, if web surveys are being used in a mixed mode environment, alongside CAPI or CATI, then the case for using a screen by screen construction is stronger. One could argue that it is more akin to the way in which questions are 'served' and answered in these modes.

On-line versus off-line interviewing

An on-line survey is one in which the respondent accesses the questionnaire instrument on a website and completes it, via their web browser, while connected to the Internet. Respondents can be directed to the Universal Resource Locator (URL) either through paper instructions, for example sent by regular mail or left by an interviewer, or in an email, possibly with a hyperlink.

On-line surveys need constant contact between the respondent's computer and the web server upon which the instrument is located. Thus one needs to consider whether or not this requirement is likely to be acceptable to respondents. For Intranet surveys, for example of employees of a business or other organisation, this is likely to be perfectly acceptable. One proviso is that the connection speed between respondent's computer and web server must be sufficient to ensure that there are not unacceptable delays in the processing of individual questions.

However, on-line methods raise a number of issues for general population surveys. The first of these concerns the length of time that a respondent is required to be on-line to complete the survey. This is likely to be of particular concern to those who pay by the minute for their time on-line. One could offer to compensate respondents for the cost of their time on-line but we need more research to find out whether or not this will be perceived as an adequate incentive for all respondents.

As outlined above, on-line surveys can be problematic if the time it takes for the response to one question being transmitted to the server and for the server to respond is deemed to be excessive. For general population surveys, where few households currently have high speed Internet access, this is a key concern. This suggests that on-line surveys are only feasible for general population surveys where there are few questions being asked and the duration of the interview is short.

In an off-line survey, respondents may initially go on-line to download a file, containing the survey instrument, to their local computer, completing the survey off-line before going back on-line to transmit the completed questionnaire back to the host. An alternative is for respondents to be sent a file, either by regular mail on CD or floppy disk or as an attachment to an email. Respondents need to install the file on their computer before answering the questionnaire. Once the questionnaire is completed, respondents can go on-line to return the completed questionnaire. There are other concerns, such as security or computer functionality, that may be relevant to a decision about on-line or off-line surveys. Respondents' competence in the use of the Internet may need to be higher to complete all the required tasks for off-line use than is the case for on-line use.

Off-line surveys are preferred when the survey is longer and more complex. However, off-line surveys can introduce other concerns. For example, the time that it takes for the questionnaire instrument to download to the respondent's computer may be perceived to be excessive. In addition, respondents may

be unwilling to download files to their own hard drive, worried that they may contain viruses or otherwise damage their computer. A possible alternative to downloading is to send respondents a file via regular mail, for example on CD or floppy disk, or as an email attachment. However, as with the download method this still requires some degree of trust in the integrity of the files being sent. It adds to the burden on respondents and for some may be enough to dissuade them from participating. Off-line surveys are likely to work best when the files that need to be installed on a respondent's computer are relatively small. This means that there may be less opportunity to build complex instruments, for example with extensive interactive edits and multi-media if, as a result, respondents are required to download large computer files.

Plain HTML versus advanced programming

The simplest approach to designing web questionnaires is to provide a plain HTML form that respondents can access via their normal browser. However, plain HTML is limited. It is necessary to supplement HTML with the use of advanced programming languages, such as JavaScipt, to allow the use of interactive edits and routing and the addition of features such as pop-up help and progress bars.

One could argue that the possibility of including such features represents a radical step forward compared with what is possible with conventional paper self-completion forms. However, the use of advanced programming languages can be problematic since different browsers may be inconsistent in the way in which they interpret Java and JavaScript. Further, the addition of such features necessarily results in the file size of the instrument growing. This impacts on download times and increases the risk of non-response.

It is worth noting that usability tests performed by the US Census Bureau suggested that respondents rarely made use of on-line help. This was true irrespective of how it was presented, for example via buttons, hyperlinks or icons (Kanarek and Sedivi, 1999).

Security

Security is a major issue for government surveys. Respondents to official surveys need to be assured that the data that they give us will be kept secure. At the same time, we need to devise systems that protect the integrity of our own data from hackers (Ramos, Sedivi and Sweet, 1998 and Clayton and Werking, 1998). The US Census Bureau has developed a three level security system including the use of encryption, authentication and a firewall. Encryption provides strong security of data on the Internet while it passes between respondent and the Bureau. Their encryption solution requires respondents to have version 4.0 or higher of either Netscape Communicator or Microsoft's Internet Explorer and enables strong 128-bit encryption. Once received at Census bureau, the data are protected by a firewall that guarantees that others from outside cannot have access to the data (Kanarek and Sedivi, 1999).

There is a tension between the strength of security and survey response. The experience of the US Census Bureau has been that the more stringent the security the lower is the response. In part, this appears to be related to technical issues, such as respondents not having the required browser version or encryption level. It is also possible that requiring the use of usernames and passwords to access a web survey may be problematic for some respondents (Sedivi, Nichols, Kanarek, 2000)

Data quality

One of the attractions of web based data collection, compared with paper self-completions, is the improvement in data quality that is offered with the use of CAI methods. If the technical issues noted above can be overcome, web CASI opens up the possibility for more complex questionnaires to be self-

administered than is possible with paper based approaches. Complex routing can be incorporated in a way that is not feasible in a paper document. Computations and edits can be carried out at the time of the interview and inconsistent or improbable responses checked with the respondent. This is analogous to the move from pencil and paper methods to CAPI and CATI.

An important aspect of data quality is the reduction of measurement error. This arises when inaccurate answers are recorded for respondents. There are different sources of measurement error, such as poor question wording and differences arising from the mode in which the interview is conducted. It is possible that there will be mode effects arising from the switch from other modes to web CASI. For example, compared with CAPI or CATI, there is a difference between the way in which information is presented to respondents – a move from aural to visual presentation. The speed with which respondents read and respond to questions can't easily be controlled. Clearly more research is needed in this area to examine such questions.

Survey response

Currently, web surveys have tended to achieve lower response than mail surveys. The US Census Bureau has found no evidence from its trials, largely among businesses, that offering a web option in addition to other modes leads to an overall increase in response rate (Sedivi, Nichols and Kanarek, 2000). Part of this is likely to be accounted by technical problems discussed earlier. Another possible explanation offered relates to respondents' concerns about privacy and confidentiality (Couper, 2000).

Response rates to self-completion surveys tend to be lower than to interviewer administered surveys and there is every reason to expect that this will be the case for web surveys too. CAPI and CATI achieve higher response than mail surveys because of interviewer involvement in the initial recruitment of respondents and in sustaining respondent involvement. Interviewers can be good at persuading respondents to participate by explaining the value of the survey and the respondents' participation. During the interview itself, interviewers can develop a rapport with respondents that encourages them to continue. For conventional surveys, the proportion of respondents who refuse to complete an interview once started is low. This contrasts with web surveys. Opinion on the optimal length of web surveys is divided but anecdotal evidence suggests that 15-20 minutes is as much as one can expect. This compares with CAPI/CATI surveys that can range from 30-40 minutes up to 90 minutes or more.

One interesting feature about the analysis of the profile of the on-line population is the over-representation of younger adults. This is one sub-group which tends to be under-represented in random probability sample surveys of the general population. Web CASI might be a way to increase response in this sub-group. There is little evidence on this idea, but what there is tends to suggest that there may be limited or no gains, in mixed mode surveys, from offering respondents a choice of response mode. For example, the US Census Bureau tested whether or not response was boosted by offering both mail and telephone options. Overall 5% of the sample responded by phone but the overall level of response (mail and phone combined) was the same as for when only a mail option was offered (Dillman, Clark and West, 1995).

Questionnaire designers need to be aware that the use of more advanced techniques may impact on respondents' ability to respond. The more complex the questionnaire instrument is, and the more that elaborate programming is embedded within it, the greater will be the size of the resulting file that respondents will need to download to run the questionnaire. This will impact on the time it takes to download the questionnaire and is very likely to impact on response.

Design principles

It has been argued that the same visual design principles that apply to the design of paper questionnaires apply for web surveys (Dillman, 2000). Respondents have the same requirement for information that is presented clearly and efficiently. Layout and design should aim for respondents to read every word of each question and in a prescribed order.

Dillman has developed a set of 14 design principles for web surveys. These are:

1. Introduce the web questionnaire with a welcome screen that is motivational, emphasises the ease of responding, and instructs respondents about how to proceed to the next page
2. Provide a PIN number for limiting access only to people in the sample
3. Choose for the first question an item that is likely to be interesting to most respondents, easily answered, and fully visible on the welcome screen of the questionnaire
4. Present each question in a conventional format similar to that normally used on paper self-administered questionnaires
5. Restrain the use of colour so that figure/ground consistency and readability are maintained, navigational flow is unimpeded, and measurement properties of questions are maintained
6. Avoid differences in the visual appearance of questions that result from different screen configurations, operating systems, browsers, partial screen displays, and wrap-around text
7. Provide specific instructions on how to take each necessary computer action for responding to the questionnaire, and give other necessary instructions at the point where they are needed
8. Use drop-down boxes sparingly, consider the mode implications, and identify each with a "click-here" instruction
9. Do not require respondents to provide an answer to each question before being allowed to answer any subsequent ones
10. Provide skip directions in a way that encourages marking of answers and being able to click to the next applicable question
11. Construct web questionnaires so they scroll from question to question unless order effects are a major concern, or when telephone and web survey results are being combined
12. When the number of answer choices exceeds the number that can be displayed in a single column on one screen, consider double-banking with an appropriate grouping device to link them together
13. Use graphical symbols or words that convey a sense of where the respondent is in the completion process, but avoid those that require significant increase in computer resources
14. Exercise restraint in the use of question structures that have known measurement problems on paper questionnaires, such as check-all-that apply and open-ended questions

Another view is that the web is a fundamentally different medium from paper and that much more research is required before we can determine optimal designs (Couper, 2000). Couper suggests that design issues interact with the type of web survey being conducted and the population which is being targeted. For example, an optimal design for a survey of teenagers may be quite different from that which is required for a survey of elderly people.

Dealing with the variety of computer hardware and software that may be used by respondents to access the survey also needs to be kept in mind. A range of factors, such as operating system, browser type and version and Internet connection speed may affect the functionality of the survey instrument. Most of these are outside our control. The result may be that some respondents may not be able to access the questionnaire at all, others may find it slow to respond and/or the questionnaire does not display as intended. One solution to these problems, employed by Statistics Canada in some of the web surveys that they have undertaken, is to build a customised web browser and deliver it to the respondents with the

questionnaire application. The drawback of this approach is that it then requires respondents to download, or install, larger files and this may impact adversely on response.

3. Criteria for evaluating web data collection software

Following on from the above discussion, we can start to think about the sort of criteria that we might use to evaluate the efficacy of web data collection software. The following criteria are provisional and we would welcome comments and views. They have been informed by the specific needs of Social Survey Division (SSD) of the ONS and some may be particular to our context as a government agency. There are possible tensions

a) Provide integration with CAPI/CATI software

Given that it is our expectation that web CASI will initially develop as part of a mixed mode design, we want any product to integrate with software used for CAPI/CATI. Ideally, it should be possible to produce a web CASI questionnaire from the same data model used to produce a CAPI or CATI instrument.

b) Easy to use

The software should be easy to use for questionnaire developers.

c) Sufficient functionality

Any software product should have the same functionality as we would expect from any CAI product, e.g. automated routing, range checking, programmable checks on consistency, computer assisted coding.

d) Form navigation and form design

The product should allow for flexibility in the look and feel of the data entry window. Both a screen by screen presentation and a plain HTML form are required. The developer should have choices about how to allow the respondent to navigate through the form, e.g. option of using previous/next question/page buttons including the option to disable comparable browser buttons. Ideally, there should be options to mix visual presentation of questions and answers, e.g. through use of radio dials, drop down boxes, tick boxes; whether or not and to include progress monitors (e.g. bars, questions on route information). Other useful options include decisions about the provision of interactive help, e.g. with choice of tags, buttons and pop-ups. Question and answer categories should remain in view and wrap round when viewing window is resized by user.

e) On-line and off-line modes

Both on-line and off-line data entry should be supported.

f) Not platform or browser specific

In the developers' and users' environment, the software should not be dependent on the use of a particular platform or browser. Or at the very least, the software should have full functionality in the dominant platform and browser environment.

g) Works well with low speed Internet connection

In the UK, to date there has been low take-up of high speed Internet access amongst domestic consumers. Therefore, web CASI software should have the expectation that most users will be accessing the instrument via a low speed Internet connection.

h) Application is robust

In production environment, it is critical that the application is robust, e.g. that multi-user access doesn't create adverse response times or the web server to crash.

i) Allows remote administration
The ONS is split across five sites in England and Wales and the server which will host a web survey may not be co-located with the developers of the instrument. Therefore, we require that our web CASI software has the facility to enable the installation, configuration and maintenance of the questionnaire instrument, and associated databases, to be carried out remotely, i.e. away from the web server itself.

j) Security enabled
In government surveys, security of respondents' data is a key concern. Software should provide for data encryption and support common security applications, e.g. Secure Socket Layer (SSL).

k) User authentication
There is a need to provide for a system of user authentication, e.g. to ensure correct respondent completes a form once only.

4. An evaluation of Blaise Internet Services (IS)

In Social Survey Division of ONS we have been using CAI in our surveys since the early 1990s. Blaise is our preferred CAI software product and we are keen to use Blaise for CASI via the Internet. Blaise IS has been produced by Statistics Netherlands as an add-on module of Blaise. In this section, with reference to the criteria listed in the previous section, we describe our experience of using Blaise IS. To date, we have restricted our work to office testing of the beta version of Blaise IS 1.1. Office testing does not provide an adequate environment to test all of the criteria but allows us to comment on some important aspects.

Blaise IS overview

Blaise IS produces an internet-ready questionnaire using a standard Blaise data model that has been prepared and complied in Blaise for Windows **version 4.3 or higher**.

Blaise IS provides two methods of producing a questionnaire:

1. Blaise IS System Manager produces a dynamic HTML form which presents each question screen by screen to respondents, or
2. An HTML Generator produces a plain form in HTML in full view.

The dynamic HTML form has been designed for use with on-line interviewing and it requires that the respondent's computer is in constant contact with the host server. In this version, automated routing, range and consistency checks are supported. The plain HTML form can be completed off-line and can be sent to respondents as an e-mail attachment or downloaded from a website. The form is static and therefore it is not possible to include automated routing or consistency checks.

Blaise IS requires Microsoft Internet Information Server version 4 or higher at the server end.

Evaluation of Blaise IS

For the purposes of testing we developed a questionnaire based on an existing data model used for one of of our CAPI surveys.

We were able to produce a web version of the questionnaire using essentially the same data model that had been prepared for our CAPI survey. However, we did not find it easy to use the Blaise IS System Manager/HTML Generator. The absence of full documentation meant that it was necessary to contact Blaise Support before we could successfully install the questionnaire on our pseudo 'web server'. A

particular problem, for us because we can't be sure of having day-to-day access to the web server, is the lack of a remote administration feature. We were able to find a workaround solution by ignoring all the system manager error messages that were being generated.

Version 1.1 of Blaise IS does not have the full functionality that we require. For example, it does not allow the use of external files and it is not possible to use checks/signals with the static web form.

The look and feel of the web forms are, in our view, sub-optimal. Figure 1 shows an example page generated by the Blaise IS System Manager of the dynamic HTML form. With the dynamic HTML form a respondent is presented with a question per page.

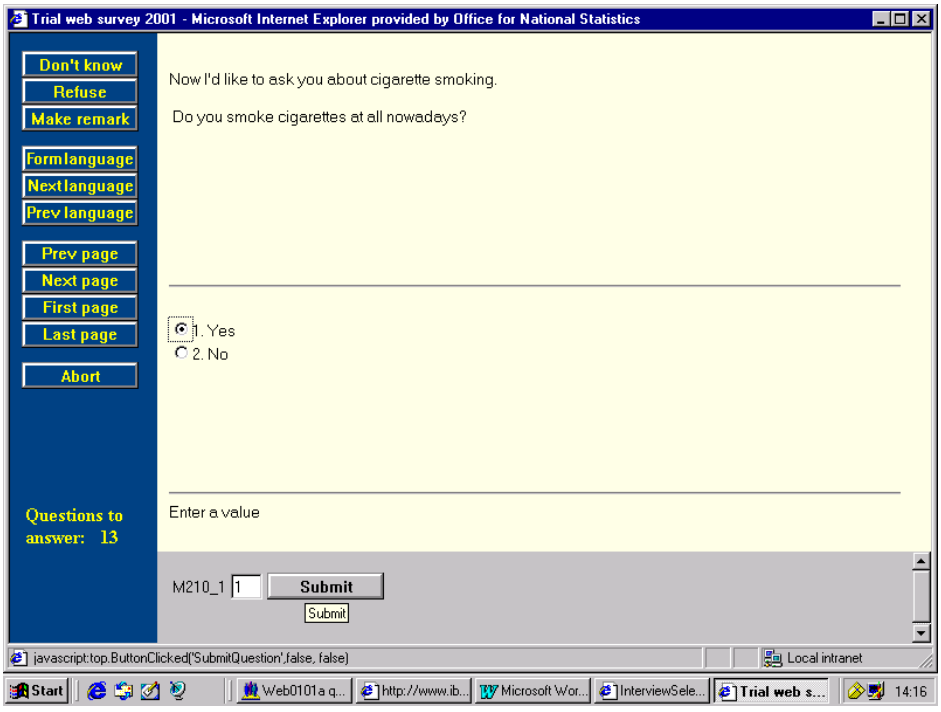
The default screen layout, we feel, is not suitable for respondents. It is too busy and we would like the option to remove, and re-position, the buttons down the left-hand side of the screen.

Using the mouse to point and click is a convenient way for respondents to submit answers. However, if one wishes to use the keyboard, the tab key must be used to navigate around the screen; an approach which is fine for trained interviewers but not necessarily intuitive to respondents. In addition, the <Enter> and <Esc> keys do not perform their normal Windows function which again may be counter-intuitive.

The content and presentation of error messages (Figures 3 and 4) are other areas for design improvement. We found that, on occasions, it is necessary to scroll across the screen to view the whole question because text has not wrapped round (Figure 5). (our office monitors were set at 800x600).

The look of the plain HTML form is less problematic but the positioning of answer boxes was sometimes out of vision (Figure 6).

Figure 1 Question presentation with dynamic HTML form



As our work, to date, has been within the office we have only tested Blaise IS with Internet Explorer version 4 and 5. It is perhaps unrealistic to expect that web survey software will work properly on all platforms and with all versions of all browsers. However, it is most important that the vast majority of potential respondents can use the software.

Blaise IS has been tested by Statistics Netherlands with version 4 of Internet Explorer and Netscape run on a Microsoft Windows platform.

Figure 2 Entry out of range error message

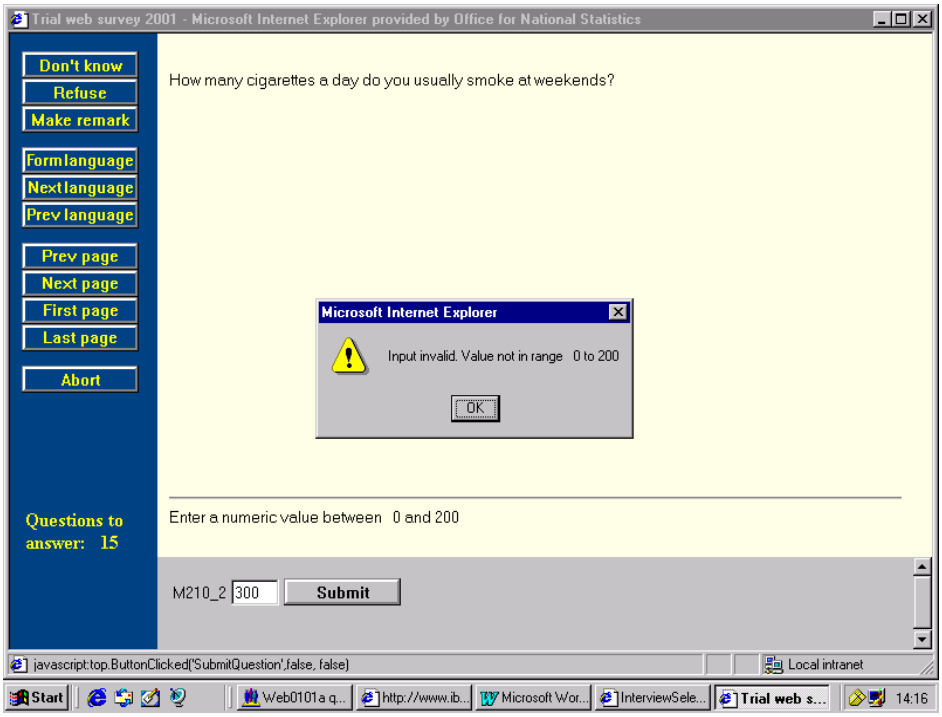


Figure 3 Signal check message

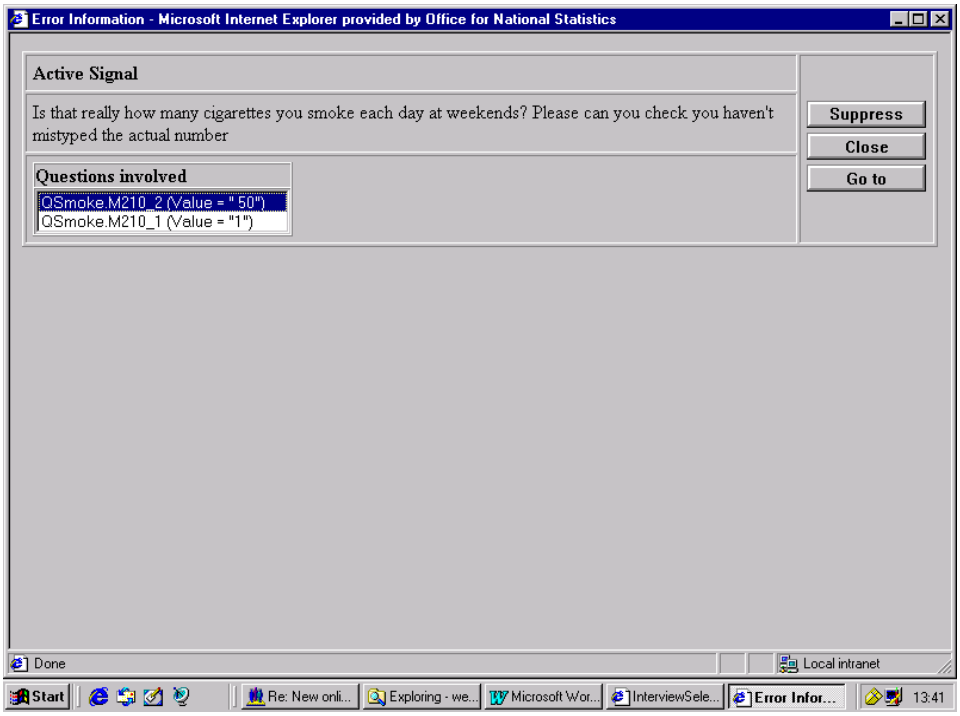


Figure 4 Failure of question text to wrap round

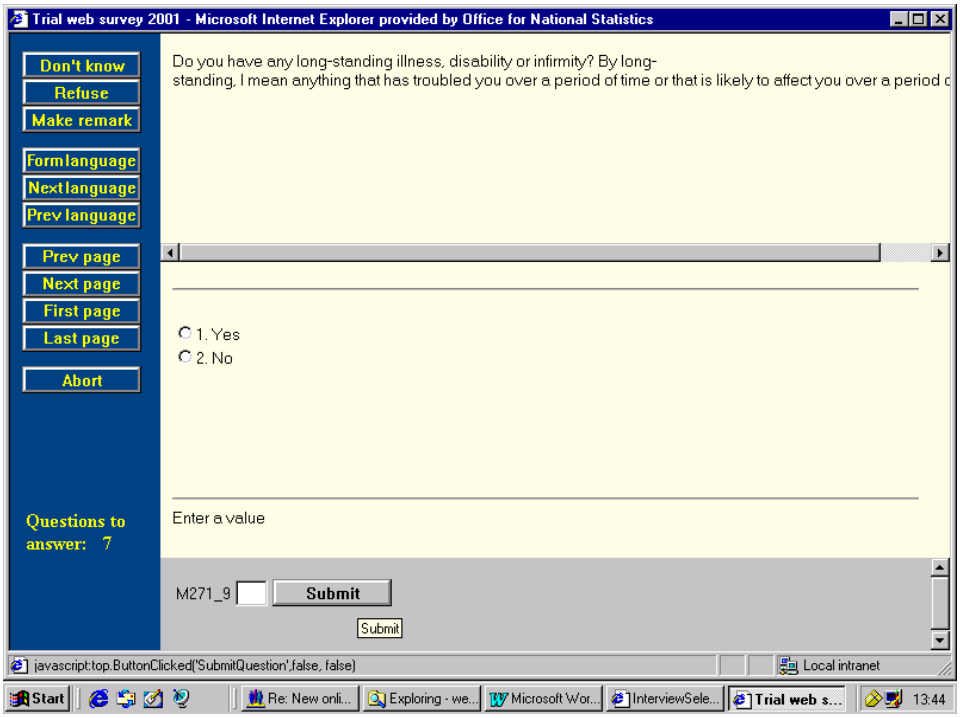


Figure 5 Question presentation with static HTML form

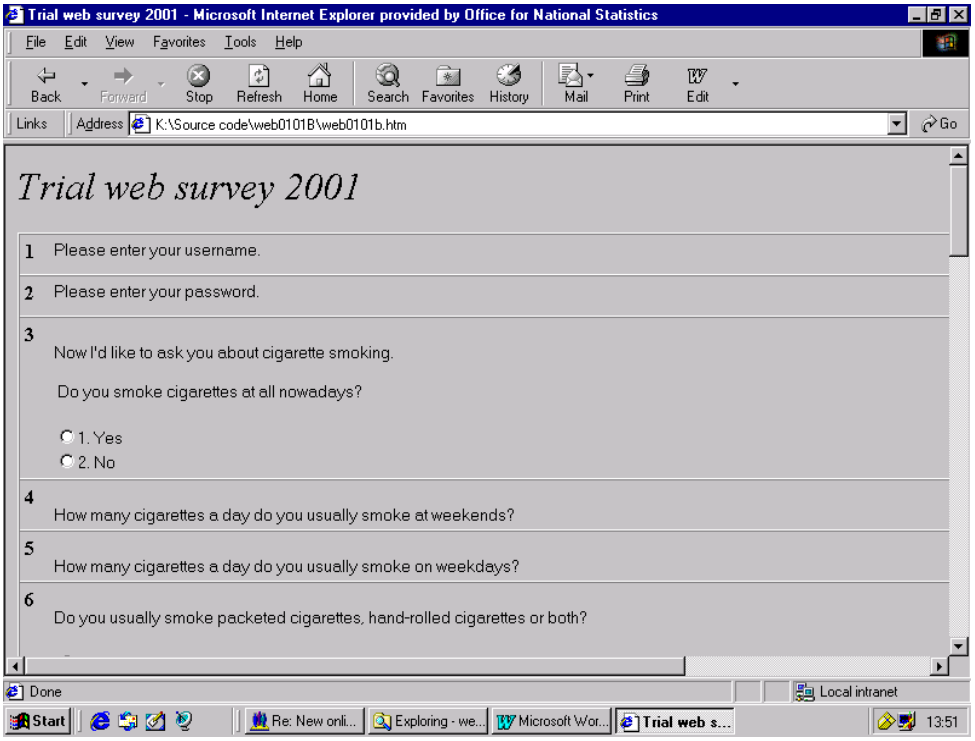
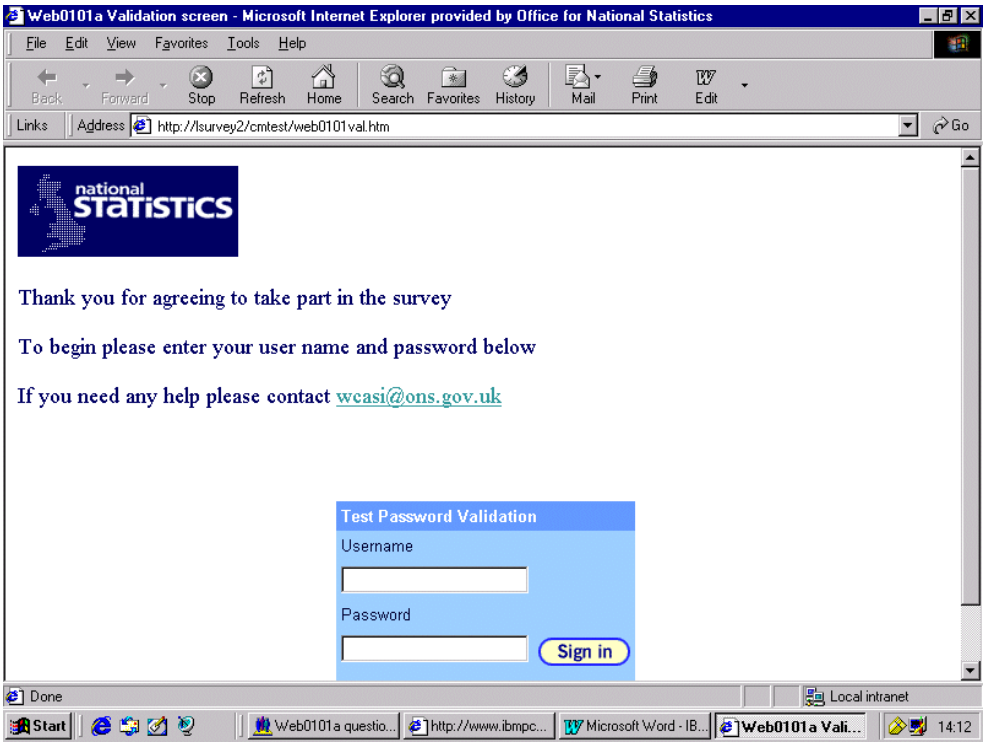


Figure 6 User authentication



Blaise IS supports Secure Socket Layer, a level of data encryption that meets our requirements for the security of data being transmitted.

Blaise IS provides a default Gateway, or welcome, page for respondents. Ahead of a Gateway page, we will need to authenticate users and we are thinking we might handle this based around a system of usernames/passwords. Figure 2 shows a validation page which we have developed. This is an HTML form which runs 3 checks against a survey database:

1. Username exists;
2. Respondent has not completed the survey previously;
3. Correct password for the username.

A successful authentication sends respondents to the Blaise Gateway page. Once into the questionnaire, we need a method to identify who is responding to the survey and we would like to avoid the need for respondents to type in an individual identifier, such as a serial number.

Table 1 summarises our initial evaluation of version 1.1 of Blaise IS. Overall, our evaluation suggests that there is more development needed of the software before we could contemplate using it in a production environment.

Table 1 An initial evaluation of Blaise IS version 1.1

Criteria	Blaise IS version 1.1
a) Provide integration with CAPI/CATI software	√√
b) Easy to use	√
c) Sufficient functionality	X
d) Form navigation and form design	X
e) On-line and off-line modes	√
f) Not platform or browser specific	√
g) Works well with low speed Internet connection	?
h) Application is robust	?
i) Allows remote administration	X
j) Security enabled	√√
k) User authentication	X

Key: √√ = Meets our requirements, √ = Nearly meets our requirements X = Doesn't meet our requirements, ?= Can't comment at this time

5. Conclusion

This paper has suggested that the design and implementation issues that arise when developing a CAI instrument for self-completion over the Internet are considerable. In the case of functionality, such as automated routing, range and consistency checks, the needs are the same as for a CAI instrument administered in other modes, such as CAPI or CATI. In other areas, for example form layout, error messages and interactive help, the self-completion element introduces new demands.

The challenges for CAI software developers are also considerable. This paper has suggested the sort of criteria against which software will be judged and applied these to Blaise IS version 1.1. Our initial evaluation is that Blaise IS requires further development before we can be confident we can use it in a

production environment. We understand that a number of the deficiencies identified are to be addressed in the release of version 2.0 of Blaise IS. We understand the release of this version has been pushed back some months and we anxiously await its release.

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