New Technologies in Census Data Collection
Part 2: Developing an Electronic Questionnaire

Select Topics in International Censuses[1]

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INTRODUCTION

Converting a paper questionnaire to an electronic format involves more than simply replicating the paper questionnaire on a screen of a mobile device, such as a tablet PC, smartphone, or a laptop. The device used affects the way that enumerators interact with the questionnaire. Some questions may need to be changed to make it easier for the enumerators to work quickly and accurately on the mobile device. Further, added features like data validation, edits, and preloaded answers can be included in an electronic questionnaire. Specifications for these features must be written when developing the questionnaire, in order to program them into the software application. This document offers guidance on what to consider when adapting the questions in a paper questionnaire to work in an electronic questionnaire. This is the second in a series of briefs that presents an overview of what to consider when using new technologies in census data collection.

ADAPTING A PAPER QUESTIONNAIRE TO ELECTRONIC FORMAT

When converting a paper questionnaire to an electronic one, the questionnaire should be adjusted for the different ways in which the interviewer interacts with the mobile device. For example, a tablet PC or smartphone screen is often much smaller than the paper used to print a paper questionnaire. The screen will not be able to fit the same number of questions from a page of a paper questionnaire without compromising usability.

In addition, questionnaire designers should consider how to take advantage of the added features of an electronic questionnaire. These include the ability to preload existing data; implement consistency checks, range checks, and edits; take GPS coordinates; and offer on-screen help features.

Below are some considerations to keep in mind when adapting a paper questionnaire to an electronic one.

Roster (Grid/Matrix) vs. Verbatim Questions

A roster is a grid with the "questions" indicated only by brief terms in the column headings. A roster is often used in paper questionnaires to record tabular data and to save space on the paper. Verbatim questions are those that enumerators read as written on the questionnaire. In an electronic questionnaire, rosters may need to be converted to verbatim questions since the screen on a mobile device is often too small for enumerators to view the roster comfortably. Using verbatim questions with customized prefills may improve usability and accuracy of the responses. For instance, in a roster, enumerators must navigate a grid, making sure that the responses are recorded in the correct row. The verbatim questions allow for specific questions about each person on the roster. For example, for a question like "How old is [name]?" the [name] can be prefilled with the name of the relevant household member from the roster, one person at a time. Box 1 shows an example of the difference between roster and verbatim questions.

[1] This technical note is one in a series of "Select Topics in International Censuses" exploring matters of interest to the international statistical community. The U.S. Census Bureau helps countries improve their national statistical systems by engaging in capacity building to enhance statistical competencies in sustainable ways.

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Box 1.

Comparison of Roster and Verbatim Questions

A. Roster

D2	D3	D4
Name of the deceased	Sex 1M 2F	Age at death
1.		
2.		
3.		
4.		
5.		
6.		

Source: Sierra Leone Population and Housing Census, 2004.

B. Verbatim Questions

Note: The response to question D2 is given in italics. In questions D3 and D4, the name in brackets is prefilled based on the response to question D2.

D2. What is the name of the deceased?

1. *JANE DOE*

D3. Was *[JANE DOE]* male or female?

D4. How old was *[JANE DOE]* when she died?

Open-Ended vs. Closed-Ended Questions

Open-ended questions are those with no predefined answer categories. Closed-ended questions have a set of response categories that are predefined. In a paper questionnaire, open-ended questions are often used when the response categories are too numerous or when the expected responses are unknown, for example, occupation. Open-ended responses are more time-consuming to process and analyze.

An electronic questionnaire can more easily accommodate numerous response categories by using drop-down menus or look-up tables. Therefore, some open-ended questions can be converted to closed-ended questions when using an electronic questionnaire. However, using too many response options can make it difficult for enumerators to find the appropriate response item or to code consistently. In addition, if there are numerous response codes, the codes may not fit on the screen, requiring enumerators to scroll down the page. This may result in enumerators selecting response items that appear at the top of the list more frequently than those that appear at the bottom of the list, creating bias in the data. This problem may be mitigated by including a search function to allow enumerators to search for specific words or by using browse hierarchy. For example, in the case of occupation codes, use browse hierarchy to first browse by major occupation groups; then browse by occupation within the major occupation group; then select the appropriate code from the subset of occupations. Also, the order of the of response items can be randomized to avoid bias from some responses appearing at the top or the bottom of the list.

Response Format Options in an Electronic Questionnaire

The response format in an electronic questionnaire can accommodate various types of response options. Box 2 shows examples of response format options in an electronic questionnaire.

Screening Questions and Skip Patterns

Electronic questionnaires can facilitate filtering questions and skip patterns by automatically displaying only the relevant questions and skipping the irrelevant ones. The automatic skips improve accuracy of the skip patterns, eliminate the need for complex instructions to enumerators, and reduce enumerator burden.

When writing the questions, consider all branching paths of the questionnaire. The questionnaire should be developed for use under all possible situations, even for some rare situations. Further, all questions should be asked to some subset of the population; no question should be skipped by all segments of the population.

Once programmed, skip patterns are less obvious in an electronic questionnaire. There are no conventional design cues like arrows and skip instructions that are visible on the screen. Skip patterns and branching paths should be clearly specified by the subject matter specialists so that the programmers can program the application correctly. A flow chart may be useful to make sure that all branching paths are considered and no question is left unasked. See section on specifications development for more information.

One disadvantage of having skip patterns programmed into the questionnaire is that if the enumerator had made a mistake on the screening question, then a set of questions will be skipped erroneously. Since the set of questions will not appear on screen, the enumerator is not likely to detect the earlier mistake. One way to mitigate this problem is to consider using consistency checks instead of skip patterns or re-asking the screening question before a long skip.

Box 2.

Examples of Open-ended and Closed-ended Questions

A. Open-Ended Question

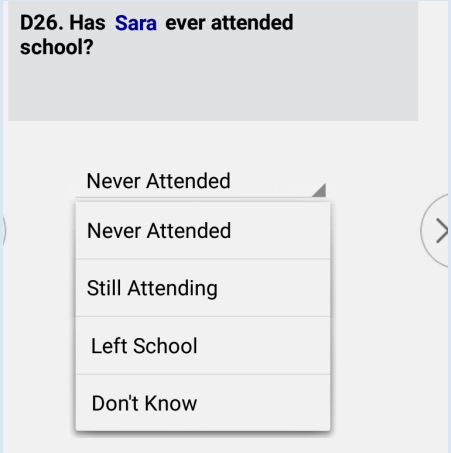
Enter the name of the next person in the household. Include everyone living or staying in this household.

Do not enter anything and press Next if all persons have been recorded.

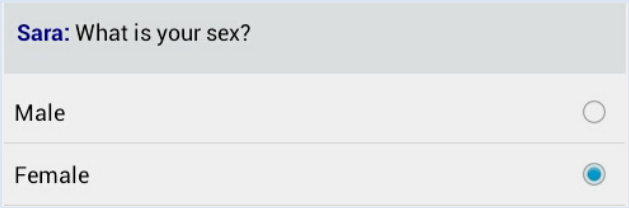
Sara

B. Closed-ended Questions

1. Drop-down menu/Table look-up



2. Radio buttons (select only one)



3. Check boxes (select all that apply)

Preloading the Questionnaire: Administrative Data and Geocodes

One advantage of using an electronic questionnaire is that some administrative data and geocodes can be used to pre-fill the census forms. Prefilling the questionnaire can save interview time and improve accuracy.

Make sure that prefilled items can be edited so that if there is an error or changes in the prefilled data, the correct information can be recorded in the field. In addition to geocodes, enumerators can take GPS measurements, which can be used to validate the geocodes and for field monitoring and management.

Office Post-Coding vs. Field Coding

Office post-coding happens when the respondent answers an open-ended question, the interviewer records the response on the questionnaire as told by the respondent, and the coding is done in the office after the interview. Field coding is when the respondent answers an open-ended question, then the enumerator codes the verbal answer into a numeric category at the time of the interview. Post-coding with a small number of specially trained staff can produce more consistent results, but it is more time consuming and costly.

In an electronic questionnaire, drop-down menus and table look-ups can be used to facilitate field coding. This reduces the need for the time-consuming exercise of post-coding while improving consistency in coding.

Multiple Language Capabilities

As with a paper questionnaire, an electronic questionnaire can be prepared in multiple languages. An option to select the language can be programmed at the beginning of the questionnaire (see Box 3 for an example). The questionnaire should be tested in all languages before implementing it in the field.

On-Screen Help

Electronic questionnaires can include a help feature available to the enumerators from the screen of their mobile device. A help feature can eliminate the need of the enumerators to carry around a separate manual and makes it easier for the enumerators to access definitions or other items needing clarification during the interview. Unlike a paper manual which is a separate document, the help feature in an electronic questionnaire can be linked to each question or a particular term that often needs clarification. Subject matter specialists should prepare the text for the on-screen help items and work closely with the programmers to implement them.

Change Log

Unlike in a paper questionnaire, changes made to an electronic questionnaire may not be immediately visible

to a reviewer. For example, changes to skip patterns in the program may not be detected unless the appropriate options are selected. It is useful to keep a change log for any changes to the questionnaire. The log can serve as a communication tool between the subject matter specialists and programmers and should be regularly maintained. A number of version control and software configuration management tools are available, such as Git. These tools can be hosted locally on an organization's own server or on a remote hosting service like GitHub.

DATA VALIDATION

One advantage of using an electronic questionnaire is that it can validate the data as the enumerator enters the responses on the mobile device. To do this, data validation rules should be written by subject matter specialists in the questionnaire development stage so that they can be programmed into the application. Subject matter specialists are best suited for writing the validation rules because they have deep knowledge of the questions and possible responses. When writing the data validation rules, the following questions should be considered:

- Which errors should be flagged?
- What should happen when there is an error? Can the enumerator continue with the interview or does the error have to be corrected before proceeding?
- What message should be displayed to the enumerators to notify them of the error?

Some checks that can be included in the validation rules are:

- Range checks: Does a value fall within a given range? (For example, age range of 0–110.)
- Inconsistency checks: Is a response consistent with a response given for an earlier question? (For example, if a respondent says she has given birth to one child, the respondent is female.)
- Data completeness checks: Is a response missing where there should be a response? (For example, sex information is missing on the household listing.)

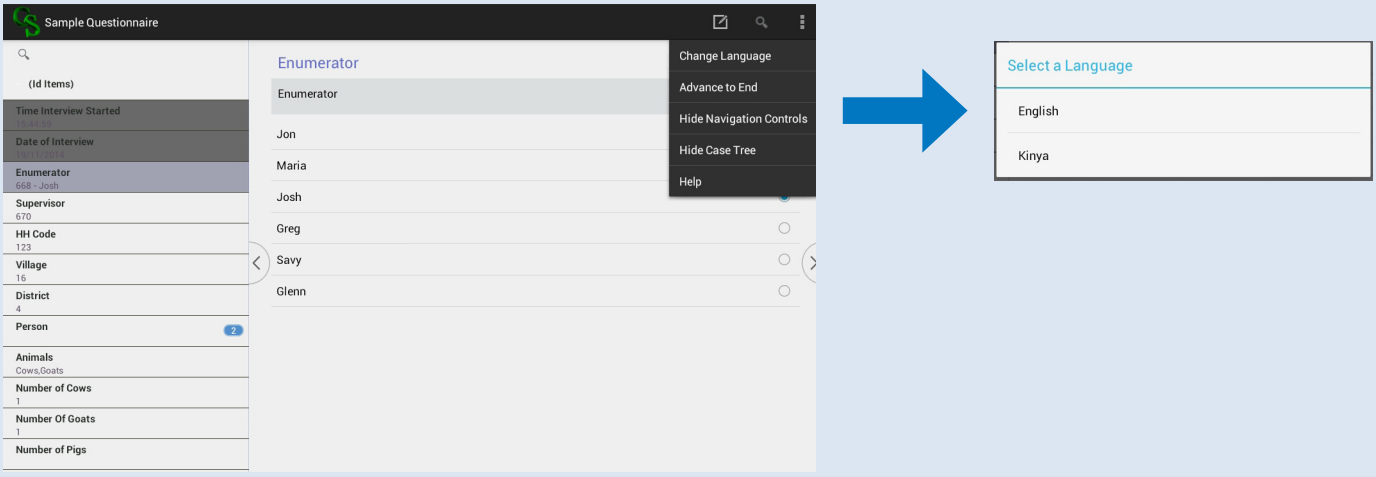
Once the errors are identified, there are two ways to manage them: hard and soft controls. With hard controls, the enumerator will not be able to continue the interview until the error has been fixed. With soft controls, the enumerator is notified of the possible error, but the interview can continue.

Hard controls are useful when there are clear known errors that must be corrected (such as a missing response for the household member's sex or 150 as the response to age). Hard controls enforce stricter quality control. However, hard controls are not recommended if it is difficult to predict all possible answers. For example, a woman who has given birth to 15 children may be unusual, but possible. Similarly, having seven members of the household die in the past 12 months would be unlikely, but may have happened. It may also be the case that the respondent is reporting deaths that ever occurred in the household, rather than in the past 12 months. For these cases, soft controls should be used. With soft controls, a message is displayed to alert the enumerator that the response entered may be erroneous, but allows the enumerator to continue with the survey after acknowledging the message.

While error checks are useful for controlling the quality of the data, too many checks can slow down the enumeration. Particularly with hard checks, the enumerator can get stuck on an error and be unable to complete the interview. Also,

Box 3.

An Example of Multiple Language Capabilities in CSPro



if the checks are misspecified, then implementing checks could lead to data quality problems. For example, in the case in which the maximum number of children is set at 5 and there is a woman who gave birth to 8 children, if the software would not allow the enumerator to enter 8 for the number of children, then the enumerator may enter 5 just so that she can complete the interview. This would result in incorrect number of children to be recorded.

Error messages should inform the enumerators about which questions have errors, what the errors are, and how to correct them. They should be short but instructive. The questionnaire application should allow enumerators to go back to the problematic questions easily in order to correct the errors. As with the data validation rules, subject matter specialists are best suited to write the error messages because of their in-depth understanding of the questionnaire content.

Too many error messages may annoy the enumerator, who then may ignore them. For missing responses, consider pointing out the missing response with an arrow and highlight instead of displaying an error message.

QUESTIONNAIRE LAYOUT AND DESIGN

Easy to use graphical layout and design on an electronic questionnaire are critical to reducing data entry errors and saving time during the interview. Electronic questionnaires should be designed in such a way that the enumerators can navigate through the questions easily, quickly, and accurately. Setting design standards and working closely with the programmers are critical to a well-designed electronic questionnaire.

There are many layout and design considerations when designing an electronic questionnaire. Compared to paper, an electronic questionnaire has more elements to design because it has more features (such as data validation and error messages). Box 4 shows the questionnaire elements that need to be designed for an electronic questionnaire.

Although programmers write the code that determines how an electronic questionnaire looks, it is important that the people who write the content work closely with the programmers so that the design is consistent with the way the questionnaire is intended to work.

Setting Design Standards

Establishing standards for layout and design creates a consistent look to the questionnaire. Inconsistent designs can confuse enumerators and lead to less efficient data collection. Standards are especially helpful when there are multiple people designing the questionnaire. Design standards should include both overall screen layout and detailed standards including font, color, placement, and other specifications. They should be developed for all elements of the questionnaire.

Many questionnaire applications (like CSPro for Android) already have built-in design standards. In such a case, the built-in design standards can be used instead of creating new ones. It is a good idea to discuss the built-in design standards with the programmers.

Design Tips

Below are some recommendations for creating design standards.

- **Make sure the enumerator instructions are clear and are placed where they are needed.** If the instruction is required before the question text, it should be placed before the question text. If the instruction is required after the question text, it should be placed after the question text.

  Example: Adapted from Census of India, 2011. Note that the question is placed between the responses "Female" and "Other".

  Q3. What is [Name]'s sex?
  1. Male O
  2. Female O

  In case the respondent wishes to return other than code 1 or 2 then give code "3"

  3. Other O

Box 4.
Elements of an Electronic Questionnaire

- Question number
- Question text
- Response items
  –Prefilled
  –Not prefilled
- Enumerator instructions (not to be read aloud)
- Help items for specific questions, definitions, general help on electronic questionnaire management
- Introductory text (for example, "Now I am going to ask you about deaths in your household in the last 12 months.")
- Error screen, with different messages for hard and soft checks
- Other design elements to ease navigation
  –Title bar
  –Button bar
  –Menu bar
  –Status bar
  –Tabs
  –Section names

- **Use different parts of the screen for different purposes.** For example, use the top left portion for module heading, left half of the screen for navigation tools, and bottom right corner for the link to the next page. Make sure that this format is consistent across all modules.
- **Use different colors for different purposes.** For example, use colors to identify modules or use different color to distinguish enumerator instructions from a question to read aloud.
- **Use different formatting fonts for different purposes.** For example, use bold font for emphasis and italics for module headings.
- **Use headings or tabs**. So the enumerators can see the bigger picture of where they are in the questionnaire.
- **Make use of icons to navigate through the screens**. For example, an arrow can be used to go to the next page. Make sure that the enumerators can easily understand the meaning of the icons.
- **Make sure that the screen is not too dense**. The questions should be clearly separated from each other.
- **Think about the number of questions to be shown on each screen**. Some people prefer one question per screen so that the enumerator can focus on one question at a time. Others prefer multiple questions.
- **Consider whether to use paging or scrolling design.** When all of the required content does not fit on one screen, the overflow content can either be placed on the next page (paging) or the page can be longer than the screen and the enumerator can scroll down the page (scrolling). If using a scrolling design, avoid nested scrolling (having a scrolling screen within another scrolling screen) or using both horizontal and vertical scrolling on the same page.
- **Consider whether to use radio buttons or drop-down lists**. Radio buttons allow the enumerator to see all the responses, while drop-down lists can save space if the responses are numerous.
- **Consider the length of text on the screen.** Too much text makes it more difficult for the enumerators to see the questions.
- **Make sure that there is enough space for answers**. For example, make sure all household members can be listed on the roster.

QUESTIONNAIRE SPECIFICATIONS

Specifications are a set of instructions for writing the program for an electronic questionnaire. They should contain all instructions for the programmers to write the code for the questionnaire, including wording for the questions, response options, skip patterns, instructions to the interviewer, data validations, error messages, output data format (e.g., flat vs. hierarchical, long vs. wide, comma-separated vs. fixed width), etc.

Although developing questionnaire specifications may seem time-consuming, it will save time in the long term by avoiding potential questionnaire programming errors. Without questionnaire specifications, the programmers, who may have limited knowledge of the questions, are left on their own to interpret the questions and make programming decisions. Further, when multiple people are involved in writing and programming the questions, the specifications help to maintain consistency. They are also useful when testing the questionnaire, because they indicate exactly how the questionnaire should work. Finally, without a paper questionnaire, the questionnaire specifications serve as documentation of the questionnaire.

Table 1 contains suggested topics to include in electronic questionnaire specifications.

QUESTIONNAIRE TESTING

The purposes of testing are to make sure that the questionnaire is:

1. **Functional:** All aspects of the questionnaire (including the question texts, response options, missing values, branching, routing instructions, error messages, and data transfer) work as intended under all possible situations.
2. **Usable:** The enumerators can effectively and efficiently make use of the questionnaire to collect necessary data.

Testing Approaches

Conventionally, pretesting has been done by having the interviewer ask the questions in the same way that the actual interview will take place, then tallying the response distribution and debriefing with the interviewers. More rigorous methods for pretesting include:

- **Cognitive interviewing**: Focuses on particular questions and understanding the cognitive processes involved in answering them through "think alouds" and probing.
- **Behavior coding**: Interviews are monitored, and interviewer and respondent behavior (such as if the interviewer asked the question exactly as worded or if the respondent asked any clarifying questions) are coded.

Table 1.
Suggested Topics to Include in Electronic Questionnaire Specifications

Topic	Specifications to Include	Benefit
Question or variable names	Specify the name of the variable for the output data file. Use question number or question names that describe the intent of the question.	Fosters consistency within and across instruments and provides data file documentation.
Universe/skip patterns	Indicate who should be answering the question.	Eliminates programmer guesswork; facilitates testing.
Preloads	Specify input source (such as what outside data source and variable names) and where preloads are used (for example, as fills, to drive routing).	Expedites programming and provides documentation for user.
Prefilled responses and wording variation	Specify "who" gets each version of the question and the preload variables or responses that drive the variants and fills.	Eliminates programmer guesswork; facilitates testing.
Routing instructions for "don't know" and "refused responses"	Indicate where these are allowable responses; indicate routing for each, or specify general rule that these responses always follow the "no" response unless otherwise specified.	Prepares instrument to handle the unexpected or less expected responses; prevents inappropriate questions from being asked in error.
Format requirements	Specify input format for dates, telephone numbers, etc.	Allows program to capture data in the desired format.
Consistency checks	For each question, specify any consistency or data completeness check that is required; indicate the specific variables or responses that are involved in the check.	Identifies key items in the interview that require editing; allows interviewers to resolve problems with the respondent during the interview.
Scripted probes	Specify the exact wording to be used to resolve detected errors; provide means to continue the interview when no resolution is possible.	Assists the interviewer and respondent in resolving consistency problems detected during the interview.
Range checks	Specify the allowable range for open-ended numeric fields.	Checks for acceptable responses.
Looping requirements	Indicate the number of times the program should loop through a series of questions (such as the number of jobs to collect in a job history).	Addresses data completeness needs by allowing adequate space in the data file.
Field widths for open-ended text responses	Specify the character limit for each field.	Ensures that sufficient space is allowed for data that require coding during or after the interview; reduces truncation.
Interviewer instructions	Specify to indicate they are not read to the respondent.	Reduces the need for hard copy reference materials.
Programmer instructions	Describe how rosters, tables, and other features are envisioned.	Promotes open lines of communication with programmer.
Date and time stamps	Indicate when the interview date and time is to be captured (such as at the start or at the end) and where timing data is needed (for each section, for a particular question block, etc.).	Captures interview data for analysis and timing data to identify sections that may need to be shortened in length.
Automated data transmission and back up	Specify if there should be automated data transmission and/or back up. If so, indicate when or how often the data transmission or back up should occur.	Reduces the risk of data loss.

Source: Adapted from Kinsey and Jewell (1998).

- **Experiments:** To determine whether the revisions are improvements by comparing original and revised questions.
- **Statistical methods:** Applying statistical methods for questionnaire evaluation, including modeling measurement error and item response patterns and predicting reliability and validity.

The six main approaches to testing a questionnaire are as follows:

- **Question-by-question testing (Q-by-Q testing):** Go through each question thoroughly and check for question wording, response options, missing values, fills, branching questions, overall appearance, validation specifications, error messages, and other aspects of the question. This is probably necessary in all testing situations.
- **Testing by task:** Divide up different testing tasks among the testers. For example, one tester checks for skip patterns and another checks for wording and response choices.
- **Scenario testing:** Construct various scenarios of responses and enter them into the questionnaire. This is essential in making sure that all possible branching paths are covered.
- **Data testing**: Examine the preliminary data output from the software program to make sure that the output fits your expectations and the survey specifications.
- **Pretesting with survey respondents**: Select some respondents and pretest them. Try to get a range of respondents.
- **Simulating survey data**: Produce random responses with the questionnaire software, then examine them for branching and other types of logical errors.

What to Test

As with a paper questionnaire, each new question should be carefully tested and old questions should be reviewed and evaluated. Electronic questionnaires require more rigorous testing than paper questionnaires because an electronic questionnaire has more features, such as range checks and preloads, all of which must be tested. Further, it is more difficult to test because skip instructions are not visible.

Table 2 shows a partial list of questionnaire features that should be tested, possible errors associated with them, and testing approaches that can help detect them. In addition to testing to make sure that the questionnaire works according to the specifications, testing the logistics for implementing mobile data capture cannot be over emphasized. Many agencies fail to adequately test the logistics, such as lack of electricity to charge the mobile device or the lack of Internet connectivity in some remote areas of the country, and lack of safe storage for the mobile devices.

PLANNING FOR QUESTIONNAIRE TESTING

Sufficient time and budget should be allocated for testing an electronic questionnaire. Testing should be conducted early in the preparation stage of the census life cycle so that any corrections can be made. It is often useful to prepare a written test plan with quality standards for each element to be tested so that all features of the questionnaire can be tested in a consistent manner. The consequences of not testing an electronic questionnaire adequately may mean data loss or errors in the data, which could be costly if the households have to be revisited.

Steps for questionnaire testing process may include the following:

1. Make sure that specifications for the questionnaire and for the survey output dataset have been written. The questionnaire should also be configured successfully and installed on mobile devices.
2. Identify a person or a team of people responsible for managing the testing process.
3. Form a testing team of people with different expertise (programmers, subject matter experts, researchers, field staff, etc.). Be sure to include some enumerators who will be the end-users of the questionnaire for usability testing.
4. Determine the goals of testing and develop written testing plans including timeline, quality standards, and specific testing procedures.
5. Establish a process for logging and reporting errors. This could be a database or on paper.
6. Implement the testing approaches.
7. Review identified errors, decide what changes need to be made, make the changes, then test again. When revising the questionnaire, be careful to maintain version control.
8. Continue the test-retest process until no more errors are found and critical errors have been corrected.

Table 2.

A Sample of Questionnaire Features to Be Tested, Possible Problems, and Testing Approaches to Detect Them

Questionnaire Features	Possible Problems	Testing Approach
Screen appearance	Inconsistent screen design and formatting The question is not immediately identifiable on the screen Poor visual design (cluttered, poor use of screen space, etc.)	Q-by-Q testing
Preloaded sample data and sample administration	Incorrect data formats Incorrect data order or appearance	Q-by-Q testing Testing by task Pretesting
Question wording	Inaccurately worded questions Missed words Spelling errors	Q-by-Q testing Testing by task Pretesting
Response ranges and formats	Formats do not match specifications Missing response options Inappropriate formats	Q-by-Q testing Testing by task Data testing
Missing values	Refusal, don't know, not applicable; other response options not used consistently or not at all	Q-by-Q testing Testing by task Data testing
Skip patterns—unconditional, conditional, missing values	Not all response options branch correctly Skips to wrong question	Testing by task Data testing Scenario testing Simulation
Calculations and fills	Division by zero Missing values Incorrect formulas Insufficient space reserved for fill variables	Q-by-Q testing Testing by task Pretesting
Randomization	Biased processes	Testing by task Data testing Simulation
Function keys and instructions for the interviewer	Not accessible Inaccurately worded Incorrect placement of the instructions Difficult to find on the screen	Testing by task
Rosters	Incorrect branching Insufficient calls to a roster	Q-by-Q testing Testing by task Scenario testing Pretesting
Attempt tracking and other case management features	Insufficient variables to track visit attempts Inappropriate visit slots	Testing by task Pretesting
Screening questions	Inaccuracies in determining eligibility	Q-by-Q testing Scenario testing Data testing
Termination questions	Insufficient termination codes	Q-by-Q testing
System issues	Abnormal terminations Corrupt output files	Scenario testing Testing by task
Data transmission issues	Cannot transmit data Corrupt output files	Testing by task Data testing
Data storage issues	Corrupt output files Insecure data storage environment	Testing by task Data testing
Data output issues	Mislabeled variable names Digits cut off Incorrect coding Corrupt output files	Testing by task Data testing
Logistics issues	Internet connection not available or too slow for data transmission at some locations Not able to charge mobile device at some locations	Testing by task Pretesting

Table 2.
A Sample of Questionnaire Features to Be Tested, Possible Problems, and Testing Approaches to Detect Them—Con.

Questionnaire Features	Possible Problems	Testing Approach
Equipment issues (Testing equipment functionality and usability under various environmental conditions)	Battery runs out too quickly Memory cannot hold enough cases Screen freezes Sun glare on the screen GPS functionality and accuracy	Testing by task Pretesting
Other usability issues	The device is difficult to hold with one hand The text on the screen is too small Too many questions per screen	Testing by task Pretesting

Source: Adapted from Tarnai and Moore (2004), Hansen and Couper (2004), and Brancato, et al. (2006).

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