# Chapter 4: PISA-D STRAND C COMPUTER-BASED PLATFORM

INTRODUCTION

This chapter focuses on the functionality and technical implementation of the computer-based assessment in PISA-D Strand C. It also details the PISA-D Strand C delivery system (PDS) with the computer-based questionnaires and cognitive assessments for delivery of the PISA-D Strand C survey within households in the participating countries.

The computer-based platform for the PISA-D Strand C data collection was a complex system run from an interviewer's tablet. The system integrated a case management system containing the Screener Questionnaire and case assignments, the computer-assisted personal interviewing (CAPI) programme for the Youth Interview questionnaires and a cognitive test designed for self-administration by the respondent. The system also captured questions at the end of the assessments for the interviewer to report observations of the household environment and testing circumstances.

Figure 4.1 shows the components of the computer-based platform and flow of information with the Case Management Administration (CMA) site, where sampling information is initialised and stored.

Figure 4.1   **Case Management System and delivery system workflow for PISA-D Strand C**
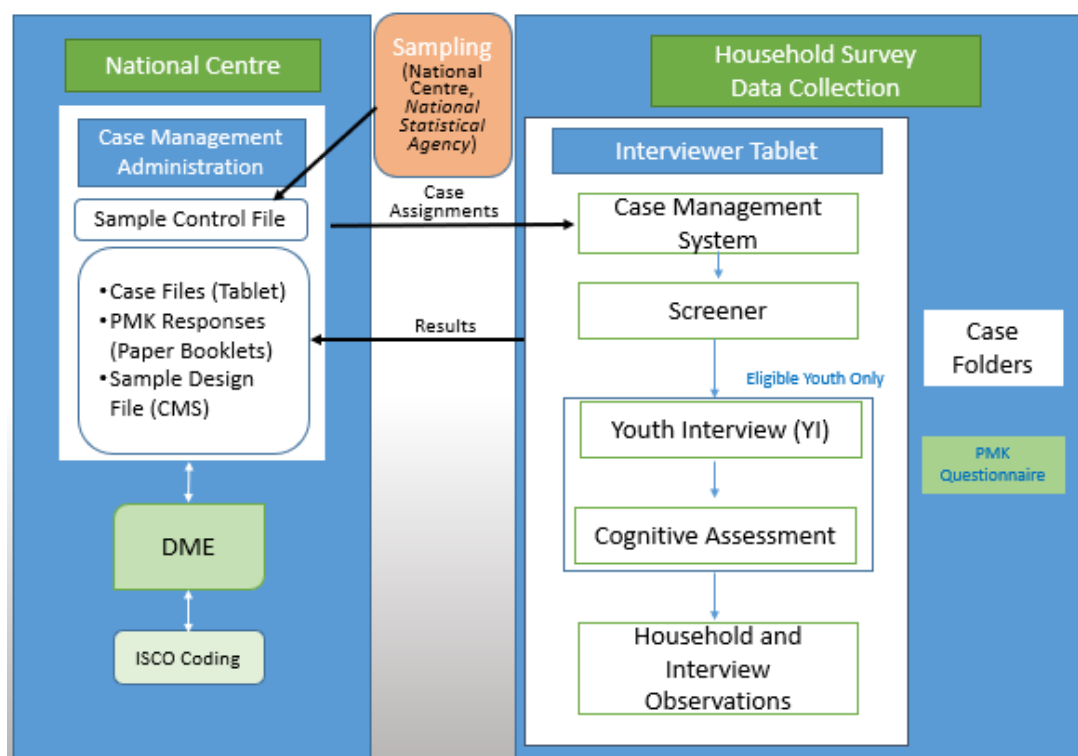
To begin, the tablets would be manually synchronised with the CMA to download case information accessible offline and locally. Interviewers would then proceed to the case location to conduct the data collection. Interviewers would begin by administering the Screener for a case (dwelling unit), where the system creates a list of household members and selects eligible respondents. Youth were considered eligible for participation in the cognitive assessments if they met the country's specified criteria (i.e. between 14 and 16 years of age and either in school in grade 6 or below or not currently attending school).

The interviewer then proceeded with the administration of the Youth Interview for each selected respondent. Based on the responses to the Youth Interview, the system would confirm the eligibility again. Eligible youth would then continue with the cognitive assessments. At the end of the assessments, the interviewer responds to a set of questions about the household environment and the administration session, and then the data are saved and stored in the tablet. A manual synchronisation between the tablet and a host server was performed later by the interviewer using an internet connection. When necessary, the entire process may span multiple visits, with each visit logged in the system.

COGNITIVE ITEM RENDERING

The cognitive items for PISA-D Strand C were implemented using web-based technologies: HTML, CSS and JavaScript®. Utilising a web browser (the PDS included a bundled version of Firefox) afforded a robust set of functionalities for screen presentations and interactivity across the range of item types. The overall user interface was based on the design for the PISA 2018 Student Delivery System but adapted for use on a touchscreen device. Common elements such as navigation, general orientations, help and progress indicators were designed to be shared across all items in each language version.

PISA-D Strand C items are generally grouped into units consisting of a set of items with a common stimulus. Each unit was constructed independently, with the questions and stimulus components developed first in English, then translated into French to create the two source language versions. Development was done by experienced web UI developers, using standard HTML components and adding custom functionality via JavaScript. Each unit could be viewed on its own or grouped with other units into a test form for delivery to students as part of the assessment.

The visual aspects of the PISA-D Strand C cognitive items and the automated coding of responses were both implemented using JavaScript®. Shared libraries were created to implement this coding in a common way. The libraries targeted the various response modes used within PISA:

- Form: for all responses using common web form elements such as radio buttons, checkboxes, dropdown menus and textboxes.
- Drag and Drop: for items using drag and drop as the response mode.
- Selection: for items where the response is given by tapping on an object or region of the screen. This can be, for instance, tapping on part of an image, a cell in a table or a segment of text.

In all cases, the coding for a specific item was specified using rules composed of conditional expressions and Boolean operators. Each library implemented appropriate conditional expressions (e.g. a CONTAINS operator in the Drag and Drop library to test if a drop target held a particular drag element).

QUESTIONNAIRE AUTHORING TOOL

The PISA Questionnaire Authoring Tool (QAT) is a platform focused on the production of questionnaires and the delivery of the items to the appropriate respondent. The questionnaire platform is accessed through a home page that gives users access to an online editor used to author the computer-based questionnaire, such as the Youth Interview for PISA-D Strand C. The QAT allows a user to add, delete or edit a question in a specific questionnaire of their choosing.

The QAT editor is a template-based questionnaire authoring system that supports the creation of multilingual content (this includes left-to-right and right-to-left texts, and extended character sets for Arabic, Chinese, Hebrew, Japanese, Korean, Russian, Thai, etc.), the design of the rules-based routings driving the questionnaire flow and the enforcement of the quality of the answers via consistency checks. The question types (i.e. Templates) that are available in the Questionnaire Authoring Tool Editor include:

- drop down (table)
- drop down
- exclusive choice
- multiple choice
- list of text inputs
- free text input
- list of exclusive choice (table)
- list of multiple choice (table)
- multiple list of text inputs (table)
- scale question type
- information.

Additionally, there are two templates for defining rules that are used within the questionnaire:

- consistency check rule
- routing rule.

The consistency check rule template supports a rule-based approach for validating the response provided by a user. The rule is evaluated when the respondent navigates away from the current question, by clicking either Forward, Back or Log Out. When the condition is true, a pop-up window will appear with a customised message to alert the interviewer and request that the response value be checked before proceeding.

A routing rule is established to allow the author to use branching within a questionnaire to direct the question flow, such as skipping a question that is not applicable to a respondent based on a particular response (or set of responses) administered prior to the skipped

question. Routing rules are implemented after the completion of a question, or set of questions, to which the rule applies. These routing rules are based on specific conditions, like the consistency checks, and are defined using IF-THEN-ELSE logic.

TABLET REQUIREMENTS

In order to maintain compatibility with the PISA delivery platform, it was mandatory that tablets used in the survey meet the following minimum system requirements:

- Microsoft Windows based operating system (Windows 8 or Windows 10 supported)
- Intel CPU 1.33GHz base rate or faster. Minimum model is Intel Atom Z3735F)
- 2GB RAM
- 32GB storage
- 10" touch screen, 1024x768 resolution.

These were the minimum requirements. Tablets with higher capabilities would obviously perform better (e.g. respond faster) when delivering the survey, but the requirement listed above were the minimum settings that would provide adequate performance.

Beyond the technical specifications, it was important to consider logistical and qualitative factors of the tablets. For instance, battery life was extremely important due to the administration circumstances. Also, ruggedness was important, given the environments in which these tablets were used. A key factor in the selection of a suitable tablet was the touch screen as this was the primary means of interaction with the tests, it needed to be clear and responsive.

A decision was made by the OECD for the same model to be used across all participating countries to help ensure a standardised administration and allow for streamlined technical support. The tablet selected was the Positivo BGH T201x device. This tablet, with a removable keyboard, met the system requirements and was available in all participating countries. Positivo BGH also offered online support for any technical issues related to the tablet's hardware and provided instructions for running the required Windows system updates and configuring the language by downloading the appropriate language pack.

TEST DELIVERY SYSTEM

The PISA-D test delivery system (PDS), integrated the case management system, computer-based assessments and questionnaires for a country into a standalone application. The PDS did not require network connectivity or external resources to operate. The software and data were downloaded to the tablet's hard drive, and results were saved to the hard drive and later uploaded to a project server using a manual synchronisation process. The components which made up the SDS included the following:

- Apache web server (*https://httpd.apache.org/*)
- MySQL database engine (*https://www.mysql.com/*)
- PHP interpreter and libraries (*http://php.net/*)
- Firefox Portable web browser (*http://portableapps.com/apps/internet/firefox_portable*).

The actual test and questionnaire content were included together with these open source applications. The PISA-D Strand C test delivery system was implemented to display this content to the interviewers (Youth Interview) and respondents (cognitive assessments), and collect the response data. Using components of the open source TAO test delivery system (*http://www.taotesting.com/*) as a basis, the custom-built system was designed for the needs of PISA. This included implementation of the test flow, which assigns the designated test form to a respondent and sequences through the questionnaire and test units in the appropriate order. It also included the functionality for collecting survey results and exporting them when the tests are completed.

The system was launched by running a custom executable programme (PISAMenu) written for controlling the delivery of the tests. From this programme, an interviewer could launch the Case Management System or launch the system diagnostics. Launching either would start the web and database servers, then launch the Firefox web browser to begin the process. When the PISAMenu programme was shut down, the various components of the PDS were also terminated.

The Case Management System provided the interviewer an accurate list of cases with addresses and administration status. Eligible youth, identified through the Screener, were presented with a 9-digit Youth ID. By clicking on the "Start Questionnaire" button from the Case Information screen, the interviewer could begin the Youth Interview. The interviewer read the questions aloud, following the protocol and entered the responses. Routing within the questionnaire was automated based on responses to the previous question or set of questions. At the end of the Youth Interview, the cognitive assessments automatically launched for any eligible test taker. The interviewer handed the tablet to the youth for the completion of the cognitive test and received the tablet back at the end of the session. The assessment was designed to be run without a keyboard and mouse, requiring only the tablet's touch screen interface. During the administration of the student assessments, it was expected that the interviewer would monitor the respondents and watch for cases of students trying to break out of the system.

An important facet of the delivery system was protecting the test content on the tablets. The PISA-D Strand C tests contain secure test materials, so people with access to a tablet used for the survey administration should not have access to the test items except during the administration session itself. To accomplish this, the files for rendering all test materials were stored in a MySQL database in each tablet. The files were stored in an encrypted format and access to these was controlled via the web server. All locally stored data was encrypted using an encryption key unique to each country and accessible only with a valid interviewer username and password. In addition, all data transfers between the tablets and CMA where encrypted and required the interviewer to re-authenticate before proceeding.

DATA CAPTURE AND SCORING RESPONSES

Student responses and other process data from the PISA-D Strand C survey were stored on the tablet's hard drive. Data was saved as the students answered each question, then exported at key intervals during the sessions. At the end of a session, the results from that session were exported in a single password protected ZIP file. The ZIP files contained XML formatted data including logs of the students' actions going through the tests and files with

the "variables" exported from the test. The following set of variables were exported for each item in the tests:

- Response: A string representing the raw student response.
- Scored Response: The code assigned to the response when the item was coded automatically.
- Number of Actions: The number of actions taken by the student during the course of interacting with the item. Actions counted were clicks, double-clicks, key presses and drag/drop events.
- Total Time: The duration of the last visit to the item by the respondent.
- Time to First Action: The time between the first showing of the item and the first action recorded by the system for the item.

All of the PISA-D Strand C item responses could be coded automatically. This included multiple choice items, drag and drop items, and numeric response items. For standard response modes, such as multiple choice or numeric entry, automated coding was done using a rule-based system. The correct answer (or partially correct answers in the case of partial credit items) were defined based on Boolean rules in a custom syntax. Simple conditionals were possible, e.g. to support different combinations of checkboxes in a multiple selection item where two out of three correct options should be selected. For numeric response items, the rules could check for string matches, which required an exact match against a known correct answer, or numeric matches, which used numeric equivalence to check an answer. For numeric equivalence, for instance, 34.0 would match 34, but they would not match when using string matching.