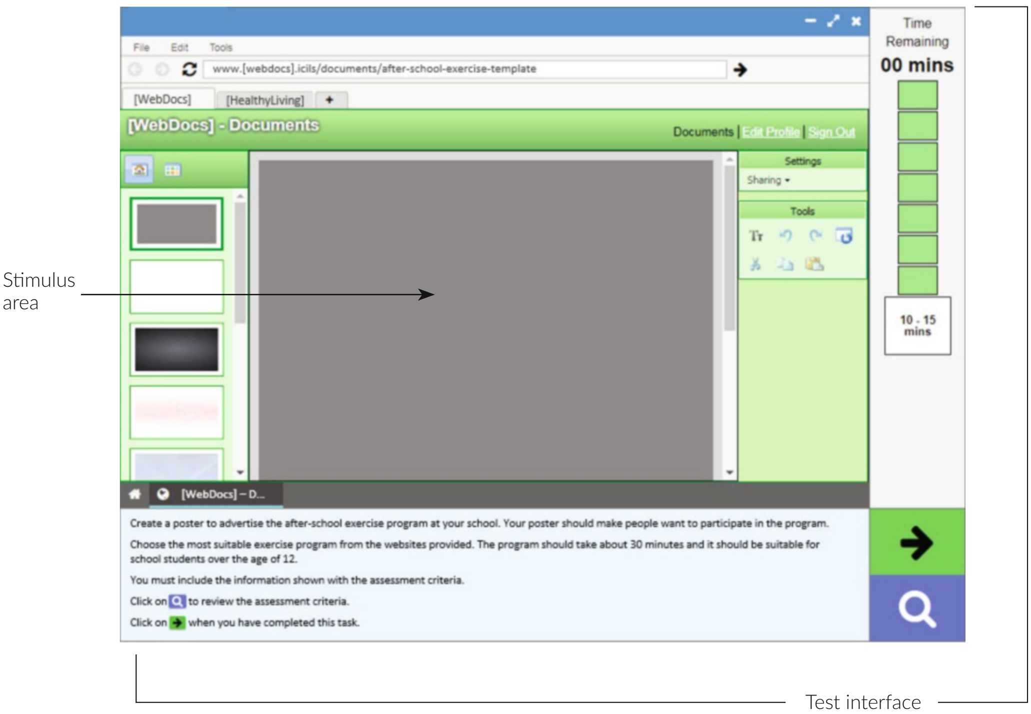
CHAPTER 5

ICILS instruments

5.1 Test instrument overview

The ICILS test is designed to provide students with an authentic computer-based assessment experience, balanced with the necessary contextual and functional restrictions to ensure that the tests are delivered in a uniform and fair way. ICILS uses a customized assessment platform that delivers the assessment content to students off-line (in the majority of schools the assessment is delivered from a USB drive). In order to maximize the authenticity of the assessment experience, the instrument uses purpose-built applications that use standard interface conventions. Students complete a variety of tasks, including multiple-choice and short text response questions, skills-based tasks, and information literacy and communication tasks, using a range of productivity software tools (such as text editors or presentation applications) and web-content. The web-content was developed for exclusive use in ICILS and was the only web-content available to students while they were completing the test. The purpose-built applications are designed to be consistent with the applications that can reasonably be expected to be within the realm of students' typical experience of computer use. Students need to be able to both navigate the mechanics of the test and complete tasks presented to them. In order to support these two purposes, the test environment comprises two functional spaces: the test interface and the stimulus area (Figure 5.1).

Figure 5.1: Test environment comprised of two functional spaces



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https://doi.org/10.1007/978-3-030-19389-8_5

5.1.1 Test interface

The test interface serves a number of purposes. Firstly, it provides students with information about their progress through the test (such as the number of tasks completed and remaining, and the time remaining). The text for each task is provided at the bottom of the interface. This text may take the form of a question to be answered (in which case the answer space is also included in the section) or an instruction relating to the execution of one or more skills. The test interface includes navigation controls that allow students to move between tasks, and an information button that allows students to access general test-taking information and task-specific information, such as scoring criteria or detailed task instructions. The test interface also houses the stimulus area (see Figure 5.1). The stimulus area is a space that contains either non-interactive content, such as an image of a login screen for a website, or interactive content, such as electronic documents or live software applications. The test interface and stimulus area were similar to that used in ICILS 2013, but their appearance was modernized for ICILS 2018. The position and functionality of the elements in the test interface (such as the navigation button and task progress indicator) were not changed, but the appearance of the elements was modernized to be consistent with 2018 interface design conventions.

5.2 The ICILS test instrument design

The ICILS test instrument consists of two tasks that are each delivered as 30-minute modules. In total, there are five CIL test modules in ICILS 2018. Three modules were developed and used in ICILS 2013, and these were kept secure to enable the establishment of trends in future cycles of ICILS. Two new modules were developed for the ICILS 2018 CIL test instrument. These new modules were designed to address contemporary relevant thematic content and software environments. Data collected from all five modules in ICILS 2018 are used as the basis for reporting ICILS 2018 CIL test results on the ICILS CIL achievement scale established for ICILS 2013. All students complete two of the five available CIL modules in a balanced rotation. The rotated module design for the modules enables the instrument to contain and consequently report on achievement against a larger amount of content (covering the breadth of the CIL framework and a range of difficulties) than any single student could reasonably complete in 60 minutes.

Two 25-minute test modules were developed for the ICILS 2018 CT test. In countries participating in the CT international option, students complete the two CT modules (in randomized order) after completing the international CIL test and ICILS student questionnaire.

5.2.1 CIL test modules

A CIL test module is a sequence of tasks contextualized by a real-world theme and driven by a plausible narrative. Each module has a series of five to eight smaller tasks, each of which typically takes students less than one minute to complete, and each of which contributes to the development of contextual knowledge that underpins work on a single large task. The large tasks typically take 15–20 minutes to complete and involve the development of an information product (such as a presentation, poster, website or social media post) that makes use of information and resources managed by students in the lead-up tasks. The large tasks are specified for students in terms of the software tool and format to be used (and consequently the format of the product), the communicative purpose, and the target audience of the information product. Students are also provided with information about the criteria that will be used to assess each large task.

The module themes are selected to be engaging and relevant to students, and the tasks are developed with a view to preventing prior content knowledge relating to a module theme from advantaging subgroups of students. This is achieved in three main ways: (1) by ensuring that all contextual information students need to manage the tasks is provided to students within the tasks; (2) by confirming that any technical (such as scientific) information used in modules is no more complex than the level of understanding typically expected of students in upper-primary/

elementary school; and (3) by preventing students from returning to earlier tasks in a module, as information in a subsequent task could be used to answer a previous task (see Fraillon 2018 for a detailed explanation of these design features).

The CIL module themes are all contextualized within a school environment, but they do not necessarily relate to conventional academic school work. For example, while modules may relate to communicating information about an aspect of science, social or environmental issues, modules can also relate to planning a class excursion or an online interest club with a community and social focus rather than academic focus.

5.2.2 CT test modules

The CT construct comprises two strands: *conceptualizing problems* and *operationalizing solutions*. Each of the two CT test modules focuses on one of these strands. Each module has a unifying theme and comprises a sequence of tasks that relate to the theme but, unlike the CIL modules, the tasks within the CT modules do not directly relate to the development of a large task. The tasks in the CT module focusing on *conceptualizing problems* related to planning aspects of a program to operate a driverless bus. This includes visual representation of real-world situations in ways that can support the development of computer programs to execute automated solutions. Examples of these are path diagrams, flow charts, and decision trees. Further tasks relate to the use of simulations to collect data and draw conclusions about real-world situations that can inform planning the development of a computer program.

In the module focusing on *operationalizing solutions*, students work within a simple visual coding environment to create, test and debug code (blocks of code that have some specified and some configurable functions) that controls the actions of a drone used in a farming context. In this module, the tasks are incrementally more difficult as the students advance through the module. The difficulties of the tasks relate to the variety of code functions that are available and the complexity of the sequence of actions required by the drone for completion of the task.

5.2.3 Test module rotation

Each student completes two of the five available CIL test modules. These modules are allocated to students in a balanced randomized design. There are 20 possible permutations of the two CIL modules selected from the five available modules. Each student is randomly allocated one module permutation.

In countries participating in the ICILS 2018 CT option, students complete the two CT test modules after having finished both the CIL test and student questionnaire. There are two permutations of the two CT modules and each student is randomly allocated one module permutation.

5.3 Types of assessment task: CIL

The computer-based assessment of CIL contains three types of task that are integrated into a single testing environment. This section contains details of each of these tasks with illustrative example[5]. Some of the example tasks are from the ICILS 2013 module "After-school exercise," where the student's central task was to design a poster to promote an after-school exercise program. Other example tasks are taken from a demonstration module created to illustrate some task formats that are otherwise only part of the secure ICILS assessment materials. This demonstration module is based on the idea of students working with a group of collaborators to plan the design of a new garden area in their school. In this module, students had to prepare an information sheet that explained and engendered support for their garden design, intended to encourage their classmates to vote for their design.

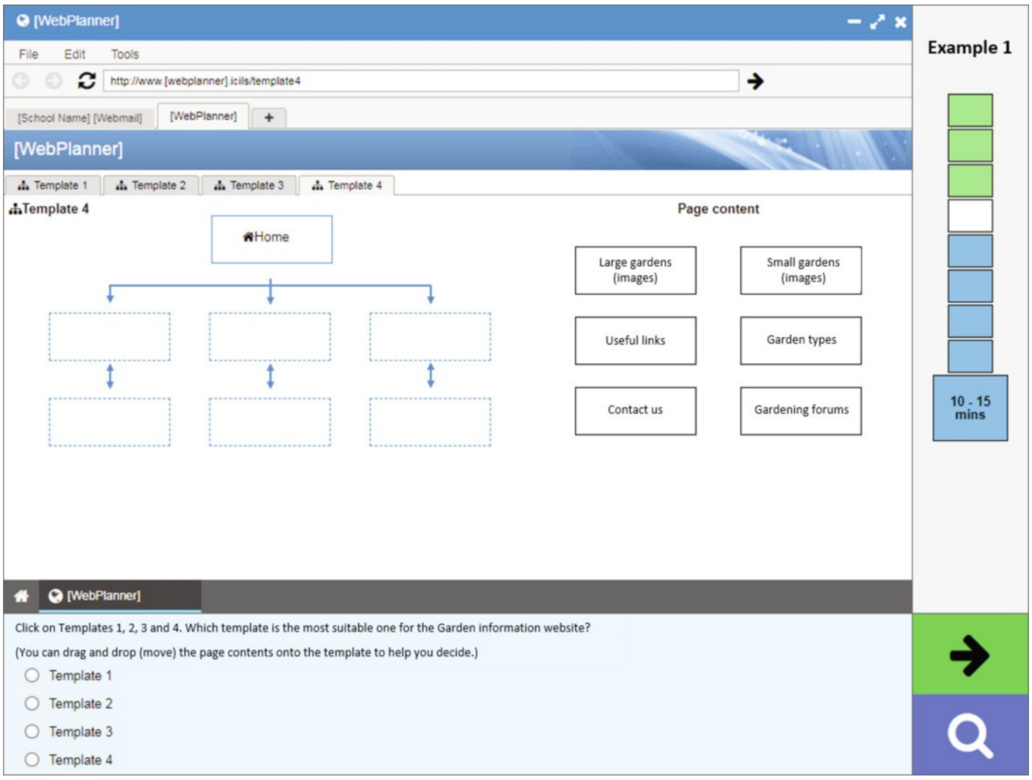
5 At the time of publication of this framework, most ICILS test tasks are secure. Where released modules do not include a particular task type, illustrative examples have been created for use in this framework to accurately represent the types of task formats and content materials used in ICILS.

5.3.1 Task type 1: Information-based response tasks

Information-based response tasks use a digital interface to deliver pencil-and-paper style questions in a slightly richer format than traditional paper-based methods. The stimulus material is typically a non-interactive representation of a computer-based problem or information source. The response formats for these tasks may be multiple choice, constructed-response, or drag-and-drop ones that use the technology only to display the stimulus material and record student responses. In these tasks, the computer-based environment is used to capture evidence of students' knowledge and understanding of CIL independently of students using anything beyond the most basic skills required to record a response.

As illustrations of an information-based response task format, example task 1 (Figure 5.2) requires students to examine four organizational-structure diagrams for a website and to select the structure that best suits a given set of six pages of content. This relates to Aspect 2.2 (managing information) of the CIL construct. Similarly, example task 2 (Figure 5.3) requires students to examine a non-interactive email (in this case a suspicious phishing email) and to respond using free text in a text entry box in the lower section of the test interface.

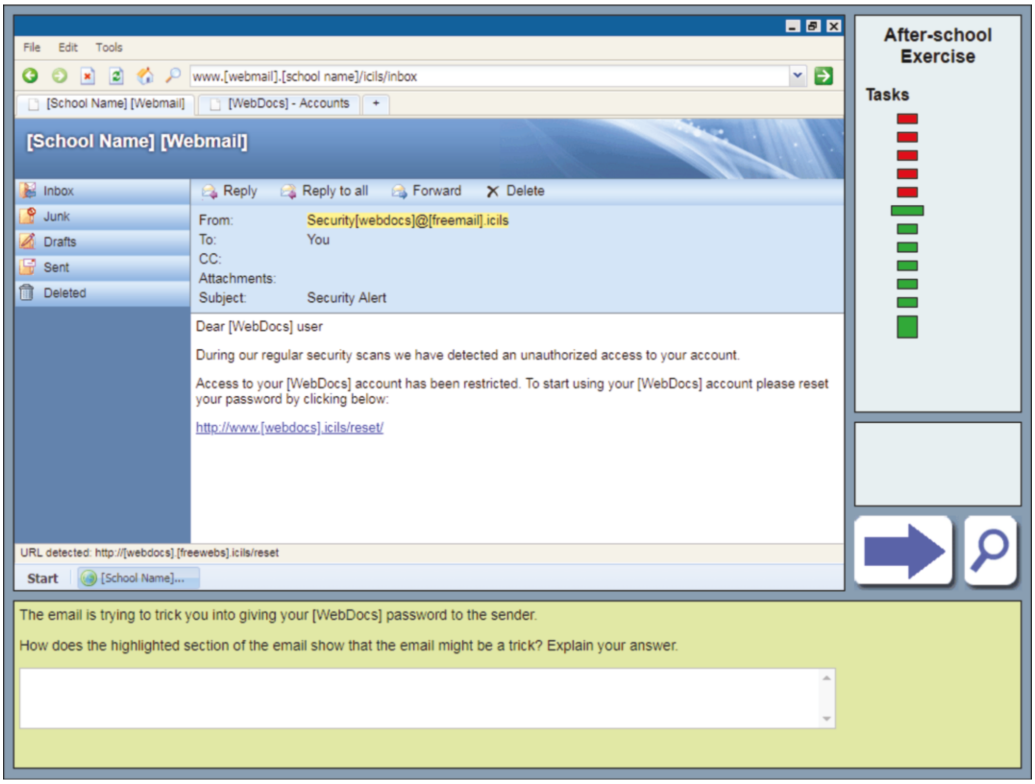
Figure 5.2: Example task 1 (a typical multiple-choice task)



The dynamic computer-based environment in example task 1 (Figure 5.2) enables students to view each of the four website structures in turn. The stimulus could also be presented in a static form (i.e., showing all four diagrams together) in a pencil-and-paper test. The simplest multiple-choice tasks in ICILS could also be presented in an equivalent form on paper.

However, because example task 1 allows students to drag and drop the web page contents into each organizational-structure template and thereby "try out" the different information structures in order to support their choice of the best structure; the computer-based stimulus facet of this task extends beyond what could be made easily available in a pencil-and-paper format. The task then enables students to provide their answer through a conventional multiple-choice format (shown in the lower area of the test interface), with one correct response that can be automatically scored. While the drag-and-drop functionality in example task 1 serves as an aid to determine the correct response, in other ICILS tasks this functionality serves as a method for recording student responses. The ICILS assessment uses the drag-and-drop task format whenever students are required to classify information into groups or to match objects or concepts according to their characteristics.

Figure 5.3: Example task 2 (open-response task from After-school exercise: ICILS 2013 test interface)



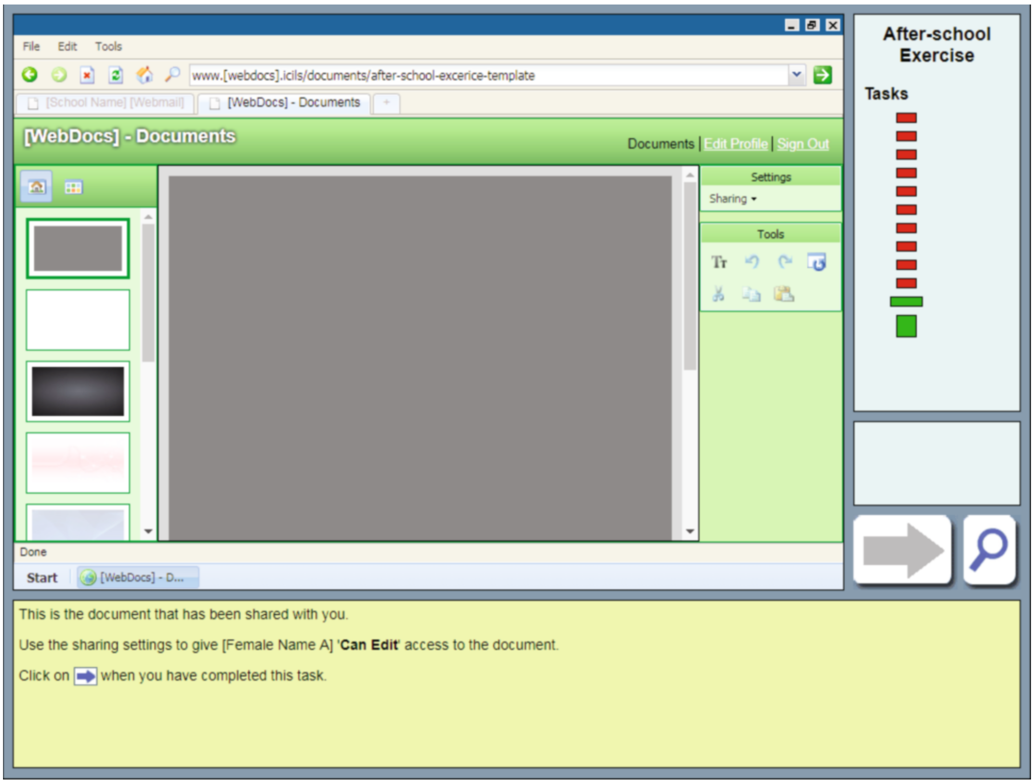
The stimulus material in example task 2 (Figure 5.3) from "After-school exercise" contains a phishing email with some metadata, such as the email address of the sender and the URL associated with the anchor text link. The task is presented to students as an example of an email that is trying to trick the user into clicking the link. Students must identify the discrepancy between the fictionally branded domain name "WebDocs" in the URL at the bottom of the email and the domain name associated with the sender's email address (freemail). Example task 2 relates to Aspect 4.2 (using information responsibly and safely) of the CIL construct. Responses to this task are recorded as text and scored by scorers according to a pre-defined scoring guide.

5.3.2 Task type 2: Skills tasks

Skills tasks require students to use interactive simulations of generic software or universal applications to complete an action. These may be single-action tasks (such as copying, pasting, or selecting a browser tab) or may contain a sequence of steps (such as "Save As" with a specific file name, or navigation through a menu structure). The tasks are designed to allow for all possible "correct" pathways for completing a task (such as using keyboard shortcuts or menu items) and the response data are recorded by the testing software. Some skills tasks only require students to execute given software commands, while others require students to execute commands along with some information processing. Skills tasks are scored automatically.

The ICILS student test contains linear and nonlinear skills tasks. A linear skills task may be as simple as executing a single command (such as opening a file from the desktop), or may require more than one step to complete the task. All appropriate methods of executing a command (e.g., using the mouse, pull-down menus, or keyboard shortcuts) are scored as equivalent and correct. Linear skills tasks that require the execution of more than one command can only be completed correctly if the commands are executed in a necessary prescribed sequence. For example, if students are instructed to copy and paste an image, they would first need to select the image and then execute the copy and paste commands in that order. Responses are automatically detected and scored once participants have reached an "endpoint" to a task.

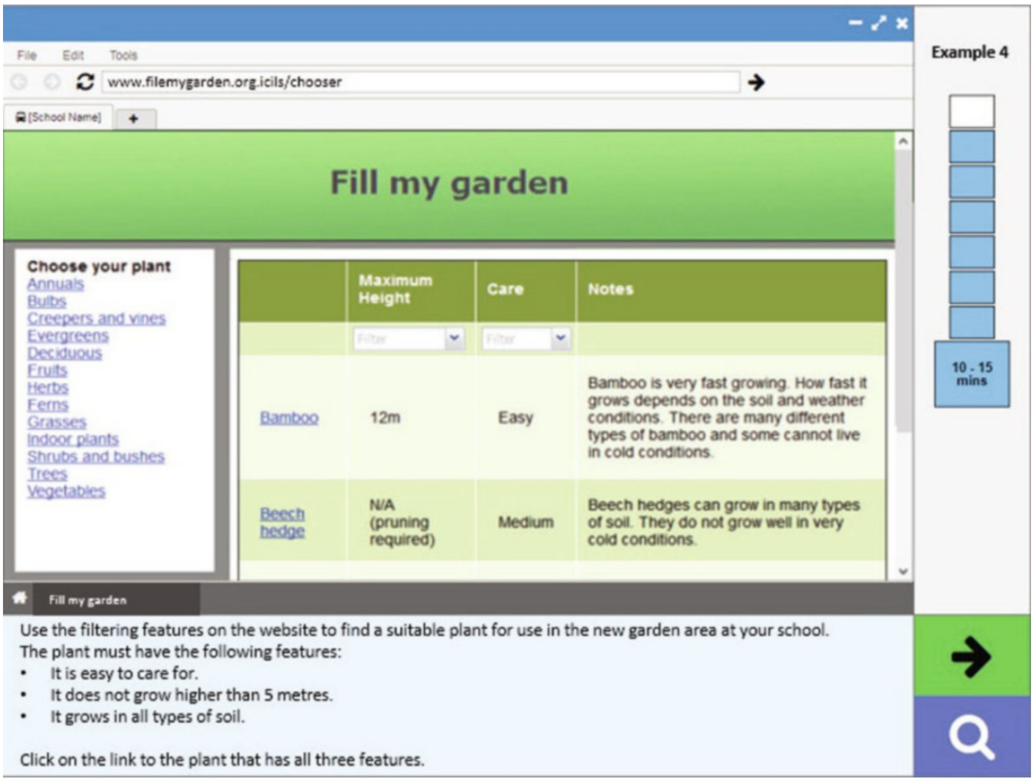
Figure 5.4: Example task 3 (linear skills task from After-school exercise: ICILS 2013 test interface)



Example task 3 (Figure 5.4) provides an example of a linear skills task that requires students to change the settings for a document in a collaborative workspace in order to permit edit access to specified people. Students must first click on the settings/sharing menu link and then enter the specified username into a field. Example task 3 relates to aspect 1.2 (computer use conventions) of the CIL construct.

Nonlinear skills tasks require students to execute a software command (or reach a desired outcome) by executing subcommands in a number of different sequences. Example task 4 is one such nonlinear skills task (Figure 5.5). This task requires students to use the filtering functions of a web-based database and to interpret some simple text in order to locate an object (a plant) that matches a given set of characteristics. The task is thus an example of a nonlinear skills task that requires information-processing skills and relates to Aspect 2.2 (managing information) of the CIL construct. The web-based database contains too many objects for a student to search manually with ease. As such, the automatic scoring gives the highest level of credit to students who make use of the filtering functions (in any order) to support their search. Students who identify the correct task without using the filters receive less credit.

Figure 5.5: Example task 4 (nonlinear skills task)

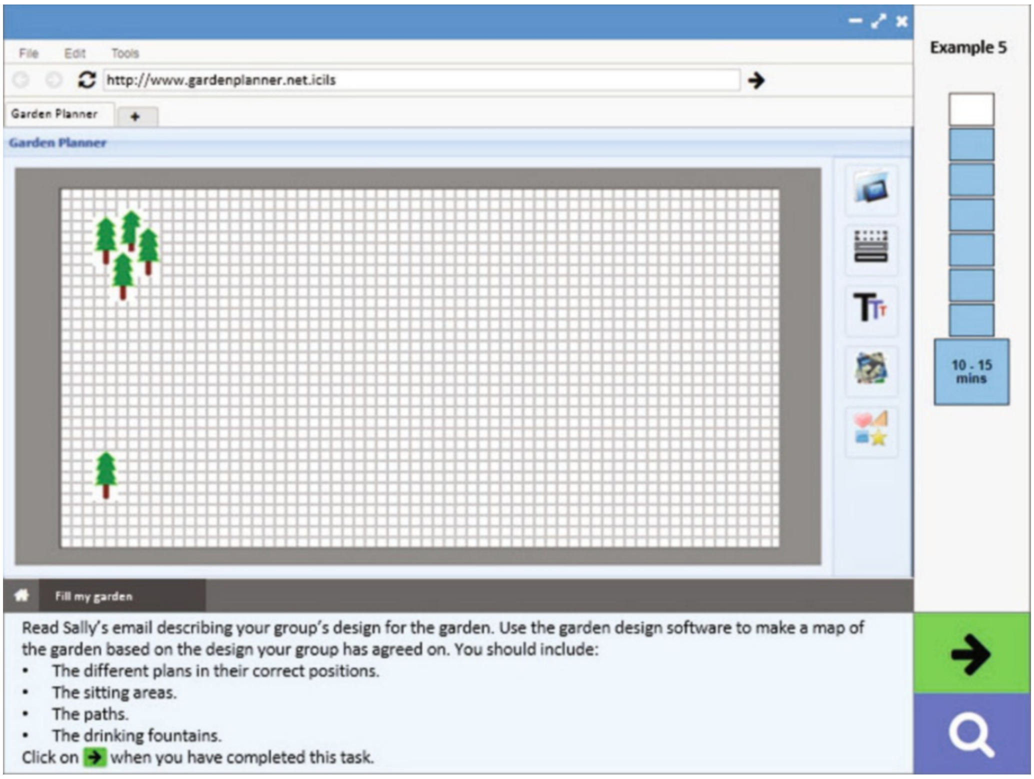


5.3.3 Task type 3: Authoring tasks

Authoring tasks require students to modify and create information products using authentic computer software applications. The applications, purpose-built for ICILS, adhere to software application conventions, such as the use of standard icons, or typical user interface feedback in response to given commands. This approach may require students to use multiple applications concurrently (such as email applications, web pages, spreadsheets, and word processing or multimedia software) as is typically required when using computer software to perform authentic complex tasks. Each student's work is automatically saved as an information product file for subsequent assessment by scorers according to a prescribed set of criteria.

Example task 5 (Figure 5.6) illustrates a simple authoring task, which requires students to use a basic map-drawing application to create a garden design plan that represents the text describing the plan. This relates to Aspect 3.1 (transforming information) of the CIL construct. The task is a simple authoring task because it asks students to use only the instructions and one piece of software (the mapping software) to complete the task. It is also simple because there is a relatively narrow range of "correct" ways in which the student can draw the garden design to match the specifications. The task is manually scored according to the accuracy with which the different specified elements of the garden design are shown in the diagram.

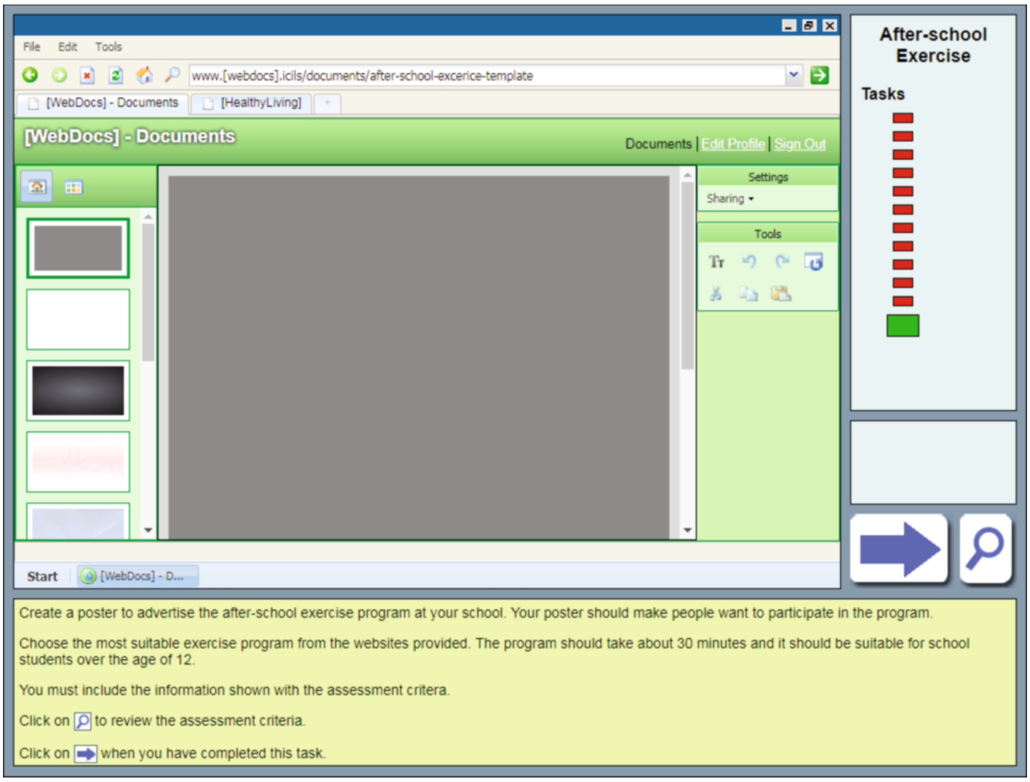
Figure 5.6: Example task 5 (simple authoring task)



Example task 6 is a more complex authoring task (Figure 5.7), requiring students to use information from a website across three sub-pages to create a poster that promotes an after-school exercise program. Students must use information from a range of electronic sources to create an information sheet that explains and promotes their garden design. The stimulus is nonlinear, fully interactive, and behaves intuitively. Students can navigate between browser tabs to switch between the website and the poster design web application. They can copy and paste text from the website to the poster software, and insert elements, such as images and text, on to the canvas of the poster design application. The final information product is saved, stored, and then scored against a set of criteria. The scoring criteria can be categorized as relating to students' use of (1) the software features and (2) the available information.

Criteria relating to students' use of software features can include their ability to use color, text formatting, and general page layout. These criteria typically have an internal hierarchy based on the degree to which the software features are used to support or even enhance the communicative effect of the information product. Criteria relating to students' use of information can also include students' adaptation of information, the relevance (and accuracy) of information selected for and used in the information product, and the appropriateness of selected information for the target audience. Note that the use of information is only assessed with respect to students' use of the information provided to them for use in the module. The highest level of credit is given to student work that demonstrates ability to use the software features to enhance the communicative effect of the information product. The lowest level of credit is given to pieces of work that show no application of the relevant software feature, or uncontrolled use (such as extremely poor color contrast or overlapping text) that inhibits comprehension of the product. The range of criteria available to evaluate example task 6 means that the single task collects evidence of student achievement relating to aspects 3.1 (transforming information) and 3.2 (creating information) of the CIL construct.

Figure 5.7: Example task 6 (complex authoring task from After-school exercise: ICILS 2013 test interface)



5.4 Types of assessment task: CT

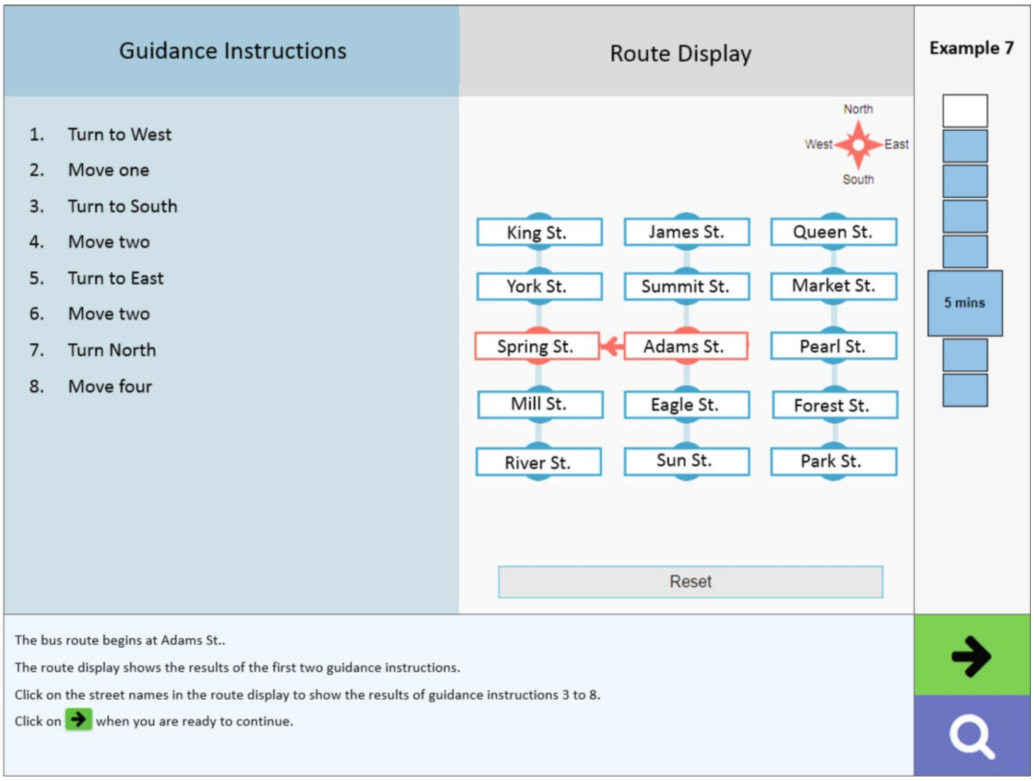
Like the CIL test, the CT assessment also contains information-based response tasks and nonlinear skills tasks (as described in section 5.3). However, in addition to these, the CT assessment instrument includes task types that are unique to the CT assessment. We created illustrative examples of these tasks specifically for inclusion in this framework[6]. These examples are similar to the tasks developed for use in each of the two CT test modules.

5.4.1 Task type 4: Nonlinear systems transfer tasks

Nonlinear systems transfer tasks require students to interpret, transfer and adapt algorithmic information so that the outcomes of the application of algorithmic instructions can be displayed visually. Example task 7 (Figure 5.8) requires students to follow the steps of a simple algorithm (left panel) and to transfer and adapt the steps of the algorithm to a visual display of their application (right panel). In successfully completing this process, students demonstrate both understanding of the visual system (including visual feedback) and the steps of the algorithm. This task relates to aspect 1.3 (collecting and representing relevant data) of the CT construct. These types of tasks are nonlinear because the student can select any node connected by the gray line in the right panel in any order, irrespective of what is described in the left panel.

6 At the time of publication of this framework, all ICILS 2018 CT items are secure. Illustrative examples have been created for use in this framework to accurately represent the types of task formats and content materials used in the ICILS computational thinking modules.

Figure 5.8: Example task 7 (nonlinear systems transfer task)



The student does not receive feedback about the correctness of their response but does receive feedback that their choice was registered. When the node selection is made, the color of the node changes from blue to red, and the line between the nodes changes from gray to red with an arrow indicating the direction of the movement between the nodes. These types of tasks are systems transfer tasks because they require the student to decode information presented in one system, deconstruct the rules of a second system, and adapt the information for transfer between the two systems.

5.4.2 Task type 5: Simulation tasks

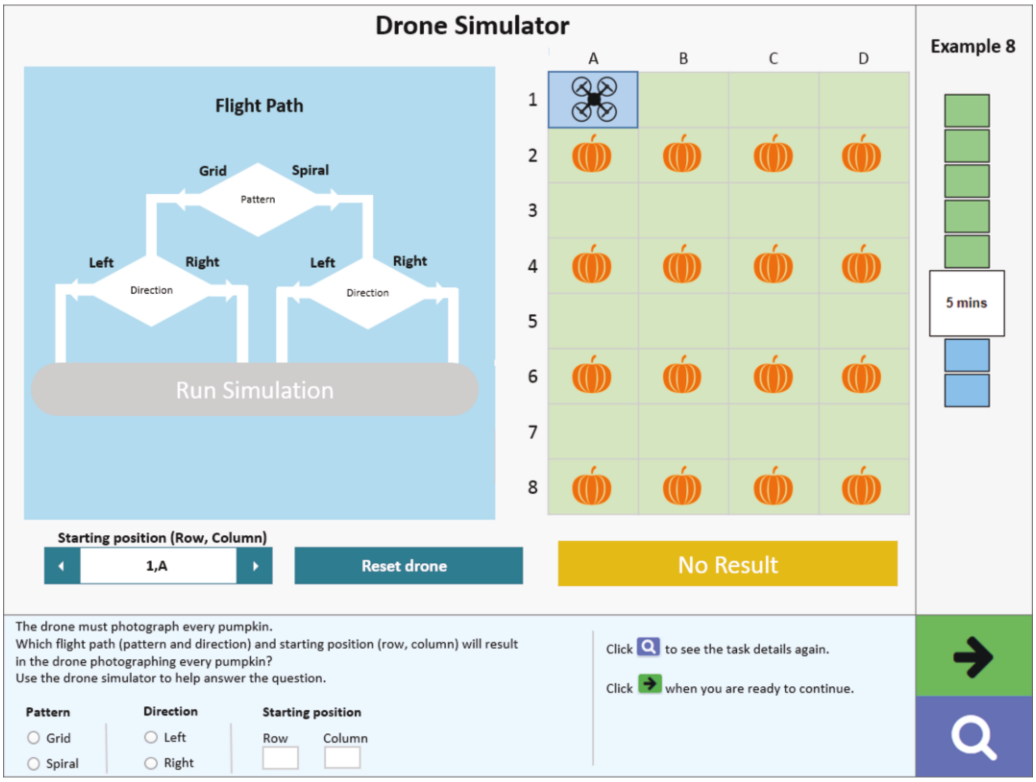
Simulation tasks require students to set parameters, run a simulation to collect data, and interpret the data to answer a research question. Example task 8 (Figure 5.9) requires students to configure the simulation tool and run simulations to identify a drone's optimal flight path over a set of pumpkins.

The decision tree (see left panel of Figure 5.9) is used to configure the flight path of the drone and the starting positon of the drone is also configured by the student. The student can then vary the configuration and run the simulation to identify the optimal parameters for the specified purpose. Simulation tasks such as example task 8 typically relate to aspect 1.3 (collecting and representing relevant data) of the CT construct.

5.4.3 Task type 6: Visual coding tasks

The ICILS 2018 CT test included a set of tasks that made use of a visual coding environment. The task interface and tasks are secure and examples of the interface and tasks cannot be shown without compromising the security of the test. Consequently, in this section, we provide only a description of the properties of the visual coding task interface and the types of visual coding tasks students may complete in the ICILS CT test.

Figure 5.9: Example task 8 (Simulation task)



Visual coding test environment

The visual coding test environment uses the ICILS test interface. However, in the ICILS 2018 visual coding test module, students were permitted to return to previous tasks within the module. This decision was made because, unlike within other ICILS test modules, the visual coding tasks did not follow a sequence where information provided in later tasks could potentially reveal the answer to earlier tasks. Consequently the visual coding test interface included the facility for students to "flag" tasks that they might wish to return to, and a navigation feature that allowed them to navigate freely between tasks they had already viewed.

The overarching objective for the visual coding environment was for students to complete coding tasks relating to the function of a drone used in farming. The visual coding test environment included the following key elements:

- A work space in which code blocks could be placed, ordered and re-ordered, and removed from the work space
- A space containing the code blocks that could be selected and used in the work space. These included code blocks controlling movement of the drone, some simple configurable commands for the drone to execute, simple loops, and conditional statements
- The facility for students to execute the code at any time and to see the consequent behavior of the drone as the code was being executed
- The facility to reset the code in the work space (to the default state of each task) and to reset the starting position of the drone before executing code.

Algorithm construction tasks

Algorithm construction tasks require students to develop their own solution to a problem by iteratively adding code blocks to the work space and executing the algorithm to see the results. These tasks typically allow for a variety of solutions with differing complexity (variety of code blocks) and depth (the number of levels deep nested codes are executed). Student responses are scored with respect to the accuracy with which the code achieves the specified goal, as well as the efficiency of the code, taking into account the number of code blocks used and the students' use of looping and conditional logic the algorithm. These tasks relate to aspect 2.2 (developing algorithms, programs and interfaces) of the ICILS CT framework.

Algorithm debugging tasks

Algorithm debugging tasks require students to modify an existing algorithm (configuration of code blocks in the work space) to solve the problem presented by the task instructions. In these tasks the students are presented with an existing set of code blocks in the work space, a description of the intended outcome of executing the code and an indication that the code is not working and needs to be corrected. Students can freely modify the code and also reset the code blocks in the workspace to the default state of the task (i.e., redisplaying the original incorrect code requiring debugging). Students are assessed on how closely their specified solution matches the ideal solution, including how accurately the code meets the specified goal. These tasks relate to aspect 2.1 (planning and evaluating solutions) of the ICILS CT framework.

5.5 Mapping test items to the CIL and CT frameworks

The test items that comprise the assessment modules are based on the strands and constituent aspects in the assessment framework (see section 2.5). The CIL and CT frameworks are central to the process of instrument development because they provide a theoretical underpinning for the assessment and a way of describing its content. The CIL test items were mapped to the assessment strands and the constituent strands in the CIL framework (Table 5.1) and CT test items were mapped to aspects and levels in CT test (Table 5.2).

In the CIL test, more items and score points per item relate to Strand 2 and Strand 3 than the other strands of the CIL construct (see Table 5.1). The main reason for this is that the large tasks at the end of each module focus on students' creation of an information product and therefore require each of these tasks to be assessed via multiple criteria with multiple score categories. Assessment of the large tasks focuses on Aspects 3.1 and 3.2, and together these contribute the largest number of associated score points across the test modules. The test design of ICILS was not planned to assess equal proportions of all aspects of the CIL construct, but rather to ensure some coverage of all aspects as part of an authentic set of assessment activities in context. The balance of items and score points relating to the different aspects of the CIL construct reflects the balance of time that students are expected to spend completing the different tasks.

While there is a similar number of items assessing each of the two CT strands, the number of score points available for strand 2 (operationalizing solutions) is approximately double those for strand 1 (see Table 5.2). Assessment of the quality of students' operationalized solutions (typically their visual coding solutions to specified problems) are assessed using multiple criteria. The test design of ICILS was not planned to assess equal proportions of all aspects of the CT construct, but rather to ensure some coverage of all aspects as part of an authentic set of assessment activities in context.

Table 5.1: Mapping the CIL test items to the CIL framework

CIL strand/aspect	Total (Items)	Maximum total (score points)*
Strand 1: Understanding computer use		
Aspect 1.1: Foundations of computer use	2	2
Aspect 1.2: Computer use conventions	11	13
Total (strand 1)	13	15
Strand 2: Gathering information		
Aspect 2.1: Accessing and evaluating information	14	16
Aspect 2.2: Managing information	8	8
Total (strand 2)	22	24
Strand 3: Producing information		
Aspect 3.1: Transforming information	15	20
Aspect 3.2: Creating information	21	31
Total (strand 3)	36	51
Strand 4: Digital communication		
Aspect 4.1: Sharing information	7	8
Aspect 4.2: Using information responsibly and safely	3	4
Total (strand 4)	10	12

Table 5.2: Mapping the CT test items to the CT framework

CT strand/aspect	Total (Items)	Maximum total (score points)*
Strand 1: Conceptualizing problems		
Aspect 1.1: Knowing about and understanding digital systems	3	7
Aspect 1.2: Formulating and analyzing problems	2	4
Aspect 1.3: Collecting and representing relevant data	3	5
Total (strand 1)	8	16
Strand 2: Operationalizing solutions		
Aspect 2.1: Planning and evaluating solutions	4	12
Aspect 2.2: Developing algorithms, programs and interfaces	4	11
Total (strand 2)	8	23

5.6 The ICILS student questionnaire and context instruments

5.6.1 Student questionnaire

The student questionnaire is based on the review of previous research discussed as part of the contextual framework (see Chapter 4), and was designed primarily to collect data that address Research Questions 3 and 4 for both CIL and CT:

RQ3 *How do students' levels of access to, familiarity with, and self-reported proficiency in using computers relate to students' CIL and CT?*

RQ4 *What aspects of students' personal and social backgrounds (such as gender, and socioeconomic background) are related to students' CIL and CT?*

Data gathered from the student questionnaire are used for two purposes. Firstly, these data are used in analyses that examine the relationships between student-level factors and measured CIL and CT. Secondly, these data are used to provide descriptive information about patterns of computer access and use across and within countries.

The student questionnaire is designed to provide the following indices regarding student and home background:

- Students' age (in years)
- Students' gender
- Students' expected highest level of educational qualifications
- Students' immigrant background
- Students' language use at home (test language or others)
- Students' parents' highest occupational status
- Students' parents' highest level of education
- Student reports on home literacy (number of books at home)
- Student reports on ICT resources at home
- Students' experience with ICT.

The student questionnaire contains questions to generate data reflecting the following aspects of ICT use and attitudes related to ICT:

- Students' experience in using ICT (frequency)
- Students' use of ICT applications (frequency)
- Students' use of ICT for social communication (frequency)
- Students' use of ICT for exchanging information (frequency)
- Students' use of ICT for accessing online content (frequency)
- Students' use of ICT for recreational purposes (frequency)
- Students' use of ICT for school-related purposes (frequency)
- Students' use of ICT in school subject lessons (frequency)
- Students' use of ICT tools in class (frequency)
- Student reports on learning of ICT tasks at school
- Students' ICT self-efficacy
- Student reports on learning about responsible ICT use at school
- Students' perceptions about the impact of ICT for society
- Students' expectations of future ICT use for work and study
- Student reports on the extent of learning about approaches to computational thinking at school.

5.6.2 Teacher questionnaire

The teacher questionnaire is largely concerned with information about teachers' perceptions of ICT in schools and their use of ICT in educational activities in their teaching. Together with questionnaires completed by the school principal and ICT coordinator, the teacher questionnaire is based on the contextual framework (Chapter 4) and designed to collect data that address Research Question 2 for both CIL and CT:

RQ2 *What aspects of schools and countries are related to students' CIL and CT?*

The assumption is that the extent to which ICT is used in schools, and the ways in which ICT is used in schools to teach information literacy, will impact on the development of students' CIL and CT. Information from the teacher questionnaire will also be used to describe the use of ICT in pedagogy among countries and major teaching areas.

It will not be possible to link teacher-based information to individual students. Rather, that information can be used to generate school-level indicators for potential two-level regression analyses in conjunction with student-based data.

The population for the ICILS teacher survey is defined as all teachers teaching regular school subjects to the students in the target grade (generally grade 8) at each sampled school. Fifteen teachers are selected at random from all teachers teaching the target grade at each sampled school to complete the teacher survey[7]. This cluster size is required to produce:

- School-level estimates with sufficient precision to be used in analyses that examine associations with student outcomes
- Population estimates with precision similar to those generated from student data.

The teacher questionnaire consists of questions about teachers' backgrounds, their familiarity with ICT, their use of ICT in teaching a reference class, their perceptions of ICT at school, and their training to use ICT in teaching.

The teacher questionnaire is designed to generate data reflecting the following aspects of teacher perceptions regarding ICT and its use in education:

- Teachers' CIL self-efficacy
- Teachers' use of ICT tools in class
- Teacher reports on student engagement in learning activities with ICT
- Teacher reports on use of ICT in teaching and learning practices
- Teachers' perceptions of the emphasis on ICT skills development in class
- Teachers' positive views regarding the use of ICT in teaching and learning
- Teachers' negative views regarding the use of ICT in teaching and learning
- Teachers' perceptions of adequacy of resources at their school
- Teachers' participation in ICT professional development
- Teachers' perceptions of collaboration for ICT use
- Teachers' emphases on teaching approaches to computational thinking in class.

7 In small schools this means all teachers of grade 8 students.

5.6.3 School questionnaires

There are two complementary school questionnaires: a principal questionnaire and an ICT coordinator questionnaire. The principal questionnaire focuses on characteristics of the school and broad policies, procedures and priorities for ICT in the school. The coordinator questionnaire focuses on ICT resources in the school and the policies and practices that make use of those resources to support learning. While these two questionnaires should ideally be completed by different people, ICILS 2018 makes provision for the possibility that both may be completed by the same person in a small school where there is no identifiable ICT coordinator.

Principal questionnaire

The principal questionnaire is designed primarily to collect data that address Research Question 2 for both CIL and CT:

RQ2 *What aspects of schools and countries are related to students' CIL and CT?*

The assumption underlying Research Question 2 is that the extent to which, and manner in which ICT is used in schools will impact on the development of students' CIL and CT. The ICILS framework assumes that the school principal can provide important perspectives on school practices and policies regarding the pedagogical use of ICT.

The principal questionnaire also collects data that will provide further context on variation in the use of ICT in pedagogy across education systems.

The ICILS principal questionnaire covers the following areas: characteristics of the principal (including their use of ICT), school characteristics (number of enrollments, range of grades taught, characteristics of the school location, ratio of female to male enrollments), management of ICT in the school, encouragement to use ICT in teaching and learning, schools' pedagogical orientations, and provision for professional development in the use of ICT.

The principal questionnaire includes questions designed to collect data about the following contextual aspects at the school level:

- School principals' use of computers for school-related purposes (frequency)
- School size (student enrollment)
- Student-teacher ratio
- School structure and management
- Economic background of students
- School principals' perceptions of the importance of ICT use at school
- School principal reports on their expectations of teachers' ICT skills
- School principal reports on ICT policies and procedures
- School principal reports on teachers' professional development for ICT use
- School principal reports on school priorities for ICT use in teaching and learning.

ICT coordinator questionnaire

The ICT coordinator questionnaire will be designed primarily to collect data that address Research Question 2 for both CIL and CT:

RQ2 *What aspects of schools and countries are related to students' CIL and CT?*

The assumption underlying Research Question 2 is that the extent to which, and manner in which ICT is used in schools will impact on the development of students' CIL and CT. The ICILS framework assumes that the ICT coordinator can provide important perspectives on school practices and policies regarding the pedagogical use of ICT. The ICT coordinator questionnaire will also collect data that provide further context on variation in the use of ICT in pedagogy across education systems.

The ICT coordinator questionnaire collects data on ICT resources (numbers of computers of different types, availability of computers for student use, availability of other ICT devices, availability of digital learning resources, networking and internet connectivity), ICT use in the school (provision for specialist teaching of ICT, emphases in curriculum areas, learning management systems, school administration), ICT technical support (maintenance provision, support for managing resources), and provision for professional development in ICT at school.

The ICT coordinator questionnaire includes questions designed to generate data reflecting the following ICT-related aspects:

- School experience in using ICT
- School policies towards the use of ICT at school
- The computer-student ratio at school
- The quality of ICT resources at school
- Perceptions of hindrances to the use of ICT in teaching and learning at school
- Perceptions of school emphasis on teaching activities to develop students' CT skills.

5.6.4 National contexts survey

The national contexts survey is intended to collect data that primarily addresses Research Question 2 for both CIL and CT:

RQ2 *What aspects of schools and countries are related to students' CIL and CT?*

The assumption underlying Research Question 2 is that the opportunities to use ICT impact on opportunity to learn about CIL and CT and therefore on the development of student outcomes in these domains.

Data from the national contexts survey will be used to compare profiles of CIL and CT education in participating education systems. In addition, the data will provide information about contextual factors concerned with structure of the education system and other aspects of education policy for the analysis of differences in approaches to ICT-related learning across education systems. Data from the national context questionnaire will be used for two broad purposes:

- To provide systematic descriptions of policy and practice in the use of information and communication technologies in school education across participating ICILS countries
- To provide systematic data that can be used as a basis for interpreting differences among education systems in ICT-related learning outcomes as well as patterns of relationships among factors that are related to ICT-related learning outcomes.