Programme for International Student Assessment

PISA 2009 Assessment Framework

Key competencies in reading, mathematics and science

OECD

Foreword

The OECD Programme for International Student Assessment (PISA), created in 1997, represents a commitment by the governments of OECD member countries to monitor the outcomes of education systems in terms of student achievement, within a common internationally agreed framework. PISA is a collaborative effort, bringing together scientific expertise from the participating countries and steered jointly by their governments on the basis of shared, policy-driven interests. Participating countries take responsibility for the project at the policy level. Experts from participating countries also serve on working groups that are charged with linking the PISA policy objectives with the best available substantive and technical expertise in the field of internationally comparative assessment. Through involvement in these expert groups, countries ensure that the PISA assessment instruments are internationally valid and take into account the cultural and curricular context of OECD member countries. They also have strong measurement properties, and place an emphasis on authenticity and educational validity.

PISA 2009 represents a continuation of the data strategy adopted in 1997 by OECD countries. As in 2000, *reading literacy* is the focus of the PISA 2009 survey, but the reading framework has been updated and now also includes the assessment of reading of electronic texts. The framework for assessing *mathematics* was fully developed for the PISA 2003 assessment and remained unchanged in 2009. Similarly, the framework for assessing *science* was fully developed for the PISA 2006 assessment and remained unchanged in 2009.

This publication presents the guiding principles of the PISA 2009 assessment, which are described in terms of the skills students need to acquire, the processes that need to be performed and the contexts in which knowledge and skills are applied. Further, it illustrates the assessment domains with a range of sample tasks. These have been developed by expert panels under the direction of Raymond Adams, Juliette Mendelovits, Ross Turner and Barry McCrae from the Australian Council for Educational Research (ACER) and Henk Moelands (CITO). The reading expert group was chaired by Irwin Kirsch of Educational Testing Service in the United States. The mathematics expert group was chaired by Jan de Lange of the University of Utrecht in the Netherlands and the science expert group was chaired by Rodger Bybee of the Biological Science Curriculum Study in the United States. The questionnaire expert group was chaired by Jaap Scheerens of University of Twente in the Netherlands. The members of the expert groups are listed in Annex C of this publication. The frameworks have also been reviewed by expert panels in each of the participating countries. The chapters on reading, mathematics and science were drafted by the respective expert groups under the direction of their chairs, Irwin Kirsch (reading), Jan de Lange (mathematics) and Rodger Bybee (science). The chapter on the questionnaire framework was drafted by Henry Levin of Teachers College, Columbia University, New York, and is based on a review of central issues, addressed in conceptual papers for the PISA Governing Board, prepared by Jaap Scheerens in collaboration with the questionnaire expert group. The publication was prepared by the OECD Secretariat, principally by Andreas Schleicher, Karin Zimmer, Juliet Evans and Niccolina Clements.

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Executive Summary

Parents, students, teachers, governments and the general public – all stakeholders - need to know how well their education systems prepare students for real-life situations. Many countries monitor students' learning to evaluate this. Comparative international assessments can extend and enrich the national picture by providing a larger context within which to interpret national performance. They can show what is possible in education, in terms of the quality of educational outcomes as well as in terms of equity in the distribution of learning opportunities. They can support setting policy targets by establishing measurable goals achieved by other systems and help to build trajectories for reform. They can also help countries work out their relative strengths and weaknesses and monitor progress.

In response to the need for cross-nationally comparable evidence on student performance, the Organisation for Economic Co-operation and Development (OECD) launched the OECD Programme for International Student Assessment (PISA) in 1997. PISA represents a commitment by governments to monitor the outcomes of education systems through measuring student achievement on a regular basis and within an internationally agreed common framework. It aims to provide a new basis for policy dialogue and for collaboration in defining and implementing educational goals, in innovative ways that reflect judgements about the skills that are relevant to adult life.

PISA is a collaborative effort undertaken by its participants – the OECD member countries as well as over 30 non-member partner economies – to measure how well students, at age 15, are prepared to meet the challenges they may encounter in future life. Age 15 is chosen because at this age students are approaching the end of compulsory education in most OECD countries. PISA, jointly guided by the participating governments, brings together the policy interests of countries with scientific expertise at both national and international levels. PISA has been measuring the knowledge, skills and attitudes of 15-year-olds over the last ten years and is therefore able to give some insight into how countries are faring over time.

The PISA assessment takes a broad approach to measuring knowledge, skills and attitudes that reflect current changes in curricula, moving beyond the school-based approach towards the use of knowledge in everyday tasks and challenges. It is based on a dynamic model of lifelong learning in which new knowledge and skills necessary for successful adaptation to a changing world are continuously acquired throughout life. PISA focuses on things that 15-year-old students will need in the future and seeks to assess what they can do with what they have learned – reflecting the ability of students to continue learning throughout their lives by applying what they learn in school to non-school environments, evaluating their choices and making decisions. The assessment is informed, but not constrained, by the common denominator of national curricula. Thus, while it does assess students' knowledge, PISA also examines their ability to reflect, and to apply their knowledge and experience to real-life issues. For example, in order to understand and evaluate scientific advice on food safety an adult would need not only to know some basic facts about the composition of nutrients, but also to be able to apply that information. The term literacy is used to encapsulate this broader concept of knowledge and skills, and the PISA assessment aims to determine the extent to which 15-year-old students can activate various cognitive processes that would enable them to make effective use of the reading, mathematical and scientific knowledge and skills they have acquired throughout their schooling and related learning experiences up to that point.

PISA is designed to collect information through three-yearly assessments and presents data on domain-specific knowledge and skills in *reading, mathematics* and *science* of students, schools and countries. It combines the assessment of science, mathematics and reading with information on students' home background, their approaches to learning, their learning environments and their familiarity with computers. Student outcomes are then associated with these background factors. Thereby, PISA provides insights into the factors that influence the development of skills and attitudes at home and at school, and examines how these factors interact and what the implications are for policy development.

PISA uses: 1) strong quality assurance mechanisms for translation, sampling and test administration; 2) measures to achieve cultural and linguistic breadth in the assessment materials, particularly through countries' participation in the development and revision processes for the production of the items; and 3) state of the art technology and methodology for data handling. The combination of these measures produces high quality instruments and outcomes with superior levels of validity and reliability to improve the understanding of education systems as well as students' knowledge, skills and attitudes.

This publication presents the theory underlying the PISA 2009 assessment, including a re-developed and expanded framework for *reading literacy*, which incorporates an innovative component on the capacity to read and understand electronic texts, thus reflecting the importance of information and computer technologies in modern societies. It also provides the basis for the assessment of mathematics and science. Within each domain, the knowledge content that students need to acquire is defined, as well as the processes that need to be performed and the contexts in which knowledge and skills are applied. It also illustrates the domains and their aspects with sample tasks. Finally, the theory underlying the context questionnaires is presented. These are used to gather information from students, schools and parents on the students' home background and attitudes, their learning histories and their learning environments at school.

Box A ■ What is PISA?

Basics

- An internationally standardised assessment that was jointly developed by participating countries and administered to 15-year-olds in educational programmes.
- A survey implemented in 43 countries and economies in the first cycle (32 in 2000 and 11 in 2002), 41 in the second cycle (2003), 57 in the third cycle (2006) and 67 in the fourth cycle (2009).
- The test is typically administered to between 4 500 and 10 000 students in each country/economy.

Content

- PISA 2009 covers the domains of *reading, mathematics* and *science* not merely in terms of whether students can reproduce specific subject matter knowledge, but also whether they can extrapolate from what they have learned and apply their knowledge in novel situations.
- Emphasis is on the mastery of processes, the understanding of concepts and the ability to function in various situations within each domain.

Methods

- Paper-and-pencil tests are used, with assessments lasting a total of two hours for each student. In a range of countries and economies, an additional 40 minutes are devoted to the assessment of reading and understanding electronic texts.
- Test items are a mixture of multiple-choice items and questions requiring students to construct their own responses. The items are organised in groups based on a passage setting out a real-life situation.
- A total of about 390 minutes of test items is covered, with different students taking different combinations of test items.

- Students answer a background questionnaire, which takes 30 minutes to complete, providing information about themselves and their homes. School principals are given a 20-minute questionnaire about their schools. In some countries and economies, optional short questionnaires are administered to: 1) parents to provide further information on past and present reading engagement at the students' homes; and 2) students to provide information on their access to and use of computers as well as their educational history and aspirations.

Assessment cycle

- The assessment takes place every three years with a strategic plan in place extending through to 2015.
- Each of these cycles looks in depth at a major domain, to which two-thirds of testing time is devoted; the other domains provide a summary profile of skills. Major domains have been *reading* in 2000, *mathematics* in 2003 and *science* in 2006. In 2009, the major domain is again reading literacy.

Outcomes

- A basic profile of knowledge and skills among 15-year-old students.
- Contextual indicators relating results to student and school characteristics. Trend indicators showing how results change over time.
- A valuable knowledge base for policy analysis and research.

BASIC FEATURES OF PISA 2009

PISA 2009 is the fourth cycle of a data strategy defined in 1997 by participating countries. The publications *Measuring Student Knowledge and Skills – A New Framework for Assessment* (OECD, 1999), *The PISA 2003 Assessment Framework – Mathematics, Reading, Science and Problem Solving Knowledge and Skills* (OECD, 2003) and *Assessing Scientific, Reading and Mathematical Literacy – A Framework for PISA 2006* (OECD, 2006) presented the conceptual framework underlying the first three cycles of PISA. The results from those cycles were presented in the publications *Knowledge and Skills for Life – First Results from PISA 2000* (OECD, 2001), *Learning for Tomorrow's World: First Results from PISA 2003* (OECD, 2004) and *PISA 2006: Science Competencies for Tomorrow's World* (OECD, 2007). All publications are also available on the PISA website: *www.pisa.oecd.org*. The results allow national policy makers to compare the performance of their education systems with those of other countries. Similar to the previous assessments, the 2009 assessment covers reading, mathematics and science, with the major focus on *reading literacy*. Students also respond to a background questionnaire, and additional supporting information is gathered from the school authorities. In 14 countries and economies information is also gathered from the students' parents. Sixty-seven countries and economies, including all 30 OECD member countries, are taking part in the PISA 2009 assessment. Together, they comprise almost 90% of the world's economy.

Since the aim of PISA is to assess the cumulative yield of education systems at an age where compulsory schooling is still largely universal, testing focuses on 15-year-olds enrolled in both school-based and work-based educational programmes. Between 4 500 and 10 000 students from at least 150 schools are typically tested in each country, providing a good sampling base from which to break down the results according to a range of student characteristics.

The primary aim of the PISA assessment is to determine the extent to which young people have acquired the wider knowledge and skills in reading, mathematics and science that they will need in adult life. The assessment of cross-curricular competencies continues to be an integral part of PISA 2009. The main reasons for this broadly oriented approach are:

- Although specific knowledge acquisition is important in school learning, the application of that knowledge in adult life depends crucially on the acquisition of broader concepts and skills. In reading, the capacity to develop interpretations of written material and to reflect on the content and qualities of text are central skills. In mathematics, being able to reason quantitatively and to represent relationships or dependencies is more relevant than the ability to answer familiar textbook questions when it comes to deploying mathematical skills in everyday life. In science, having specific knowledge, such as the names of plants and animals, is of less value than understanding broad topics such as energy consumption, biodiversity and human health in thinking about the issues under debate in the adult community.
- In an international setting, a focus on curriculum content would restrict attention to curriculum elements common to all or most countries. This would force many compromises and result in an assessment too narrow to be of value for governments wishing to learn about the strengths and innovations in the education systems of other countries.
- Certain broad, general skills are essential for students to develop. They include communication, adaptability, flexibility, problem solving and the use of information technologies. These skills are developed across the curriculum and an assessment of them requires a broad cross-curricular focus.

PISA is not a single cross-national assessment of the reading, mathematics and science skills of 15-year-old students. It is an ongoing programme that, over the longer term, will lead to the development of a body of information for monitoring trends in the knowledge and skills of students in various countries as well as in different demographic subgroups of each country. On each occasion, one domain is tested in detail, taking up nearly two-thirds of the total testing time. This data collection strategy provides a thorough analysis of achievement in each area every nine years and a trend analysis every three. The major domain was *reading* in 2000, *mathematics* in 2003 and *science* in 2006. In 2009, it is *reading* again, building on a modified reading framework which incorporates the reading of electronic texts and elaborates the constructs of reading engagement and meta-cognition (see Chapter 1). The mathematics and science frameworks for PISA 2009 are the same as for the previous assessment (see Chapters 2 and 3 respectively).

Similar to previous PISA cycles, the total time spent on the PISA 2009 tests by each student is two hours, but information is obtained from about 390 minutes worth of test items. For each country, the total set of questions is packaged into 13 linked testing booklets. Each booklet is taken by a sufficient number of students for appropriate estimates to be made of the achievement levels on all items by students in each country and in relevant sub-groups within a country (such as boys and girls, and students from different social and economic contexts). Students also spend 30 minutes answering a background questionnaire. In addition to this core assessment, in a range of countries and economies, the assessment includes a computerised test on the reading and understanding of electronic texts.

The PISA assessment provides three main types of outcomes:

- Basic indicators that provide a baseline profile of the knowledge and skills of students.
- Contextual indicators that show how such skills relate to important demographic, social, economic and educational variables.
- Indicators on trends that emerge from the on-going nature of the data collection and that show changes in outcome levels and distributions, and in relationships between student-level and school-level background variables and outcomes.

Although indicators are an adequate means of drawing attention to important issues, they do not provide answers to policy questions. PISA has therefore also developed a policy-oriented analysis plan that goes beyond the reporting of indicators.

WHAT MAKES PISA UNIQUE

PISA focuses on young people's ability to use their knowledge and skills to meet real-life challenges. This orientation reflects a change in the goals and objectives of curricula themselves, which are increasingly concerned with what students can do with what they learn at school and not merely with whether they have mastered specific curricular content.

Key features driving the development of PISA have been its:

- Policy orientation, which connects data on student learning outcomes with data on students' characteristics and on key factors shaping their learning inside and outside school in order to draw attention to differences in performance patterns and to identify the characteristics of schools and education systems that have high performance standards.
- Innovative literacy concept, which is concerned with the capacity of students to apply knowledge and skills in key subject areas and to analyse, reason and communicate effectively as they pose, solve and interpret problems in a variety of situations.
- Relevance to lifelong learning, which does not limit PISA to assessing students' curricular and cross-curricular competencies, but also asks them to report on their own motivation to learn, their beliefs about themselves and their learning strategies.
- Regularity, which enables countries to monitor their progress in meeting key learning objectives.
- Breadth of geographical coverage and collaborative nature, which in PISA 2009 encompasses the 30 OECD member countries and over 30 partner countries and economies.

The relevance of the knowledge and skills measured by PISA is confirmed by recent studies tracking young people in the years after they have been assessed by PISA. Studies in Australia, Canada and Denmark display a strong relationship between the performance in reading on the PISA 2000 assessment at age 15 and the chance of a student completing secondary school and of carrying on with post-secondary studies at age 19. For example, Canadian students who had achieved reading proficiency Level 5 at age 15 were 16 times more likely to be enrolled in post-secondary studies when they were 19 years old than those who had not reached the reading proficiency Level 1.

PISA is the most comprehensive and rigorous international programme to assess student performance and to collect data on the student, family and institutional factors that can help to explain differences in performance. Decisions about the scope and nature of the assessments and the background information to be collected are made by leading experts in participating countries, and are steered jointly by governments on the basis of shared, policy-driven interests. Substantial efforts and resources are devoted to achieving cultural and linguistic breadth and balance in the assessment materials. Stringent quality assurance mechanisms are applied in translation, sampling and data collection. As a consequence, the results of PISA have a high degree of validity and reliability, and can significantly improve understanding of the outcomes of education in the world's economically most developed countries, as well as in a growing number of countries at earlier stages of economic development.

Across the world, policy makers are using PISA findings to: gauge the knowledge and skills of students in their own country in comparison with those of the other participating countries; establish benchmarks for educational improvement, for example, in terms of the mean scores achieved by other countries or their capacity to provide high levels of equity in educational outcomes and opportunities; and understand relative strengths and weaknesses of their education systems. The interest in PISA is illustrated by the many reports produced in participating countries, the numerous references to the results of PISA in public debates and the intense media attention shown to PISA throughout the world.

AN OVERVIEW OF WHAT IS BEING ASSESSED IN EACH DOMAIN

Box B presents a definition of the three domains assessed in PISA 2009. The definitions all emphasise functional knowledge and skills that allow one to participate actively in society. Such participation requires more than just being able to carry out tasks imposed externally by, for example, an employer. It also means being equipped to take part in decision-making processes. In the more complex tasks in PISA, students are asked to reflect on and evaluate material, not just to answer questions that have single correct answers. The definitions address the capacity of students to extrapolate from what they have learned, and to apply their knowledge in novel settings. The definitions also focus on the students' capacity to analyse, reason and communicate effectively, as they pose, solve and interpret problems in a variety of situations.

Box B ■ Definitions of the domains

Reading literacy: An individual's capacity to: understand, use, reflect on and engage with written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society.

Mathematical literacy: An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen.

Scientific literacy: An individual's scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues, understanding of the characteristic features of science as a form of human knowledge and enquiry, awareness of how science and technology shape our material, intellectual, and cultural environments, and willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen.

Reading literacy (elaborated in Chapter 1) is defined in terms of students' ability to understand, use and reflect on written text to achieve their purposes. This aspect of literacy has been well established by previous surveys such as the International Adult Literacy Survey (IALS), but is taken further in PISA by the introduction of an active element – the capacity not just to understand a text but to reflect on it, drawing on one's own thoughts and experiences. In PISA, reading literacy is assessed in relation to the:

- *Text format:* Often students' reading assessments have focused on *continuous texts* or prose organised in sentences and paragraphs. From its inception, PISA has used in addition *non-continuous texts* that present information in other ways, such as in lists, forms, graphs, or diagrams. It has also distinguished between a range of prose forms, such as narration, exposition and argumentation. In PISA 2009, the framework encompasses both print and electronic texts, and the distinctions outlined above are applied to both. These distinctions are based on the principle that individuals will encounter a range of written material in their civic and work-related adult life (*e.g.* application, forms, advertisements) and that it is not sufficient to be able to read a limited number of types of text typically encountered in school.
- *Reading processes (aspects):* Students are not assessed on the most basic reading skills, as it is assumed that most 15-year-old students will have acquired these. Rather, they are expected to demonstrate their proficiency in accessing and retrieving information, forming a broad general understanding of the text, interpreting it, reflecting on its contents and reflecting on its form and features.
- *Situations:* These are defined by the use for which the text was constructed. For example, a novel, personal letter or biography is written for people's personal use; official documents or announcements for public use; a manual or report for occupational use; and a textbook or worksheet for educational use. Since some groups may perform better in one reading situation than in another, it is desirable to include a range of types of reading in the assessment items.

Mathematical literacy (elaborated in Chapter 2) is concerned with the ability of students to analyse, reason, and communicate ideas effectively as they pose, formulate, solve, and interpret solutions to mathematical problems in a variety of situations. The PISA mathematics assessment has, so far, been designed in relation to the:

- *Mathematical content:* This is defined mainly in terms of four overarching ideas (*quantity*, *space and shape*, *change and relationships*, and *uncertainty*) and only secondarily in relation to curricular strands (such as numbers, algebra and geometry).

- *Mathematical processes:* These are defined by individual mathematical competencies. These include the use of mathematical language, modelling and problem-solving skills. Such skills, however, are not separated out in different test items, since it is assumed that a range of competencies will be needed to perform any given mathematical task. Rather, questions are organised in terms of competency clusters defining the type of thinking skill needed.
- *Situations:* These are defined in terms of the ones in which mathematics is used, based on their distance from the students. The framework identifies five situations: personal, educational, occupational, public and scientific.

However, a major revision of the PISA mathematics framework is currently underway in preparation for the PISA 2012 assessment.

Scientific literacy (elaborated in Chapter 3) is defined as the ability to use scientific knowledge and processes not only to understand the natural world but to participate in decisions that affect it. The PISA science assessment is designed in relation to:

- *Scientific knowledge or concepts:* These constitute the links that aid understanding of related phenomena. In PISA, while the concepts are the familiar ones relating to physics, chemistry, biological sciences and earth and space sciences, they are applied to the content of the items and not just recalled.
- *Scientific processes:* These are centred on the ability to acquire, interpret and act upon evidence. Three such processes present in PISA relate to: 1) describing, explaining and predicting scientific phenomena, 2) understanding scientific investigation, and 3) interpreting scientific evidence and conclusions.
- *Situations or contexts:* These concern the application of scientific knowledge and the use of scientific processes applied. The framework identifies three main areas: science in life and health, science in Earth and environment, and science in technology.

ASSESSING AND REPORTING PISA 2009

Similar to the previous assessments in PISA, the assessment in 2009 mainly consists of pencil and paper instruments. In addition, a computerised assessment of reading of electronic texts is carried out in a range of countries and economies. Both the paper-and-pencil assessment and the computer-based assessment include a variety of types of questions. Some require students to select or produce simple responses that can be directly compared with a single correct answer, such as multiple-choice or closed-constructed response items. These questions have either a correct or incorrect answer and often assess lower-order skills. Others are more constructive, requiring students to develop their own responses designed to measure broader constructs than those captured by more traditional surveys, allowing for a wider range of acceptable responses and more complex marking that can include partially correct responses.

Not all students answer all questions in the assessment. For the paper-and-pencil assessment of reading, mathematics and science, the PISA 2009 test units are arranged in 13 clusters, with each cluster designed to occupy 30 minutes of testing time. In each country, there are seven reading clusters, three mathematics clusters and three science clusters. The clusters are placed in 13 booklets, according to a rotated test design. Each booklet contains four clusters and each student is assigned one of these two-hour booklets. There is at least one reading cluster in each booklet.

For the assessment of reading, two alternative sets of booklets are provided in PISA 2009, from which a country will implement one. One set of booklets comprises items distributed across a range of difficulty similar to that of previous cycles. The second set also contains items covering the full range of difficulty, but includes more items at the easier end of the range, in order to obtain better descriptive information about what students at the lower end of the ability spectrum know, understand and can do as readers. All participating countries and economies administer 11 common clusters: five clusters of reading items, three clusters of mathematics items and three clusters of science items. In addition, countries administer one of two alternative pairs of reading clusters. The performance of students in all participating countries and economies will be represented on a common reading literacy scale.

In a range of countries and economies, the reading and understanding of electronic texts is assessed in a 40-minute test. The test units are arranged in six clusters of 20 minutes each. Two clusters are placed in a booklet, according to a rotated design, so the test material consists of six booklets with two clusters each. Every student taking part in the computer-based assessment is given one of the six booklets to work on. For the paper-and-pencil assessment as well as the computerised assessment, knowledge and skills are assessed through units consisting of a stimulus (*e.g.* text, table, chart, figures, etc.) followed by a number of tasks associated with this common stimulus. This is an important feature, allowing questions to go into greater depth than if each question were to introduce a wholly new context. It allows time for the student to digest material that can then be used to assess multiple aspects of performance.

Results from PISA have been reported using scales with an average score of 500 and a standard deviation of 100 for all three domains, which means that two-thirds of students across OECD countries scored between 400 and 600 points. These scores represent degrees of proficiency in a particular domain. *Reading literacy* was the major domain in 2000, and the reading scales were divided into five levels of knowledge and skills. The main advantage of this approach is that it describes what students can do by associating the tasks with levels of difficulty. Additionally, results were also presented through three subscales of reading: retrieving information, interpreting texts, and reflection and evaluation. A proficiency scale was also available for mathematics and science, though without levels therefore recognising the limitation of the data from minor domains. PISA 2003 built upon this approach by specifying six proficiency levels for the mathematics scale, following a similar approach to what was done in reading. There were four subscales in *mathematics: space and shape, change and relationships, quantity,* and *uncertainty*. In a similar manner, the reporting of *science* in PISA 2006 specified six proficiency levels for the science scale. The three subscales in science related to *identifying scientific issues*, *explaining phenomena scientifically* and *using scientific evidence*. Additionally, country performance was compared on the bases of *knowledge about science* and *knowledge of science*. The three main areas of knowledge of science were *physical systems*, *living systems* and *earth and space systems*. PISA 2009 will be the first time that *reading literacy* will be re-assessed as a major domain, and will provide trend results for all three domains of *reading*, *mathematics* and *science*.

THE CONTEXT QUESTIONNAIRES AND THEIR USE

To gather contextual information, PISA asks students and the principals of their schools to respond to background questionnaires of around 30 minutes in length. These questionnaires are central to the analysis of results in terms of a range of student and school characteristics. Chapter 4 presents the questionnaire framework in detail. The questionnaires from all assessments (PISA 2000, 2003, 2006 and 2009) are available on the PISA website: *www.pisa.oecd.org*. The questionnaires seek information about:

- Students and their family backgrounds, including their economic, social and cultural capital.
- Aspects of students' lives, such as their attitudes towards learning, their habits and life inside school, and their family environment.
- Aspects of schools, such as the quality of the schools' human and material resources, public and private control and funding, decision-making processes, staffing practices and the school's curricular emphasis and extra-curricular activities offered.
- Context of instruction, including institutional structures and types, class size, classroom and school climate and reading activities in class.
- Aspects of learning and instruction in reading, including students' interest, motivation and engagement.

Three additional questionnaires are offered as international options:

- A *computer familiarity questionnaire* focusing on the availability and use of information and communications technology (ICT), including where ICT is mostly used, as well as on the students' ability to carry out computer tasks and their attitudes towards computer use. The OECD published a report resulting from analysis of data collected via this questionnaire in 2003: *Are Students Ready for a Technology-Rich World? What PISA Studies Tell Us (OECD, 2005*). As part of its *New Millennium Learners* project, the OECD's Centre for Educational Research and Innovation (CERI) will be publishing a similar report using the PISA 2006 data.
- An *educational career questionnaire* collecting additional information on interruptions of schooling and changes of schools, expected educational attainment and lessons or tutoring outside of school.

- A *parent questionnaire* focusing on a number of topics including the student's past reading engagement, the parents' own reading engagement, home reading resources and support, and the parents' perceptions of and involvement in their child's school.

The contextual information collected through the student and school questionnaires, as well as the optional computer familiarity, educational career and parent questionnaires, comprises only a part of the total amount of information available to PISA. Indicators describing the general structure of the education systems (their demographic and economic contexts – for example, costs, enrolments, school and teacher characteristics, and some classroom processes) and their effect on labour market outcomes are already routinely developed and applied by the OECD (*e.g.* the yearly OECD publication of *Education at a Glance*).

COLLABORATIVE DEVELOPMENT OF PISA AND ITS ASSESSMENT FRAMEWORK

PISA represents a collaborative effort among the OECD member governments to provide a new kind of assessment of student achievement on a recurring basis. The assessments are developed co-operatively, agreed by participating countries, and implemented by national organisations. The constructive co-operation of students, teachers and principals in participating schools has been crucial to the success of PISA during all stages of the development and implementation.

The PISA Governing Board (PGB), representing all nations at the senior policy levels, determines the policy priorities for PISA in the context of OECD objectives and oversees adherence to these priorities during the implementation of the programme. This includes setting priorities for the development of indicators, for the establishment of the assessment instruments and for the reporting of the results. Experts from participating countries also serve on working groups charged with linking the PISA policy objectives with the best internationally available technical expertise in the different assessment domains. By participating in these expert groups, countries ensure that the instruments are internationally valid and take into account the cultural and educational contexts in OECD member countries. They also ensure that the assessment materials have strong measurement properties and that the instruments emphasise authenticity and educational validity.

Participating countries implement PISA at the national level, through National Project Managers (NPM), subject to the agreed administration procedures. National Project Managers play a vital role in ensuring that implementation is of high quality. They also verify and evaluate the survey results, analyses, reports and publications.

The design of the assessment of reading, mathematics and science, and the implementation of the present survey, within the framework established by the PGB, is the responsibility of an international consortium led by the Australian Council for Educational Research (ACER). Other partners in this consortium include cApStAn Linguistic Quality Control and the Department of Experimental and Theoretical Pedagogy at the University of Liège (SPe) in Belgium, the Deutsches Institut fuer Pädagogische Forschung (DIPF) in Germany, the National Institute for Educational Policy Research (NIER) in Japan, and WESTAT in the United States.

The questionnaire development of the survey is carried out by a consortium led by the CITO Institute for Educational Measurement in the Netherlands. Other partners in this consortium include the Institute for Educational Research at the University of Jyväskylä in Finland, the Direction de l'Évaluation de la Prospective et de la Performance (DEPP) in France, and the University of Twente in the Netherlands. The OECD Secretariat has overall managerial responsibility for the programme, monitors its implementation on a day-to-day basis, acts as the secretariat for the PGB, builds consensus among countries and serves as the interlocutor between the PGB and the international consortium charged with implementation. The OECD Secretariat is also responsible for the production of the indicators, and the analysis and preparation of the international reports and publications in co-operation with the PISA consortium, in close consultation with member countries both at the policy level (PGB) and at the implementation level (National Project Managers).

The development of the PISA frameworks has been a continuous effort since the programme was created in 1997 and can be described as a sequence:

- Development of a working definition for the assessment domain and description of the assumptions that underlie that definition.

- Evaluation of how to organise the tasks constructed in order to report to policy makers and researchers on student achievement in the domain, and identification of key characteristics that should be taken into account when constructing assessment tasks for international use.
- Operationalisation of key characteristics used in test construction, with definitions based on existing literature and experience in conducting other large-scale assessments.
- Validation of the variables and assessment of the contribution they each make to understanding task difficulty across the participating countries.
- Preparation of an interpretative scheme for the results.

While the main benefit of constructing and validating a framework for each of the domains is improved measurement, there are other potential benefits:

- A framework provides a common language and a vehicle for discussing the purpose of the assessment and what it is trying to measure. Such a discussion encourages the development of a consensus around the framework and the measurement goals.
- An analysis of the kinds of knowledge and skills associated with successful performance provides a basis for establishing standards or levels of proficiency. As the understanding of what is being measured and the ability to interpret scores along a particular scale evolve, an empirical basis for communicating a richer body of information to various constituencies can be developed.
- Identifying and understanding particular variables that underlie successful performance further the ability to evaluate what is being measured and to make changes to the assessment over time.
- The understanding of what is being measured and its connection to what we say about students provides an important link between public policy, assessment and research which, in turn, enhances the usefulness of the data collected.

1

PISA 2009 Reading Framework

This chapter discusses the conceptual framework underlying the PISA 2009 assessment of students' reading competencies. It provides PISA's definition of reading literacy and presents the elements of the survey which have remained consistent throughout the previous cycles, along with a new element: reading and understanding electronic texts. It describes how PISA assesses and analyses electronic reading tasks, as well as the way in which students navigate through texts and respond to the format of tasks. Sample print and electronic reading items are included throughout the chapter to further illustrate how students' skill are measured. Finally, a discussion on reading engagement and metacognition addresses the motivational and behavioural elements of reading literacy.

INTRODUCTION

Continuity and change in the reading literacy framework

Reading literacy was the major domain assessed in 2000 for the first PISA cycle (PISA 2000). For the fourth PISA cycle (PISA 2009), it is the first of the domains to be revisited as a major focus, requiring a full review of its framework and new development of the instruments that represent it.

The original reading literacy framework for PISA was developed for the PISA 2000 cycle (from 1998 to 2001) through a consensus building process involving reading experts selected by the participating countries and the PISA 2000 advisory groups. The definition of reading literacy evolved in part from the IEA Reading Literacy Study (1992) and the International Adult Literacy Survey (IALS, 1994, 1997 and 1998). In particular, it reflected IALS' emphasis on the importance of reading skills for active participation in society. It was also influenced by contemporary – and still current – theories of reading, which emphasise reading's interactive nature (Dechant, 1991; McCormick, 1988; Rumelhart, 1985), models of discourse comprehension (Graesser, Millis, & Zwaan, 1997; Kintsch, 1998), and theories of performance in solving reading tasks (Kirsch, 2001; Kirsch & Mosenthal, 1990).

Much of the substance of the PISA 2000 framework is retained in the PISA 2009 framework, respecting one of the central purposes of PISA: to collect and report trend information about performance in reading, mathematics and science. However, the PISA domain frameworks also aim to be evolving documents that will adapt to and integrate new developments in theory and practice over time. There is therefore a significant amount of evolution, reflecting both an expansion in our understanding of the nature of reading and changes in the world.

There are two major modifications in this new version of the reading framework. It incorporates the reading of electronic texts and elaborates the constructs of reading engagement and metacognition.

The PISA 2000 reading literacy framework briefly mentioned electronic texts, stating, "It is expected that electronic texts will be used in future survey cycles but will not be included in this cycle because of time and access issues (OECD, 1999). The PISA 2009 cycle is now upon us, and with it, recognition of the increasing prevalence of digital texts in many parts of our lives: personal, social and economic. The new demands on reading proficiency created by the digital world have led to the framework's inclusion of electronic reading, an inclusion that has in turn resulted in some redefinition both of texts and of the mental processes that readers use to approach texts. This edition of the framework thereby acknowledges the fact that any definition of reading in the 21st century needs to encompass both printed and digital texts.

PISA is the first large-scale international study to assess electronic reading. As such, this initiative, while grounded in current theory and best practices from around the world, is inevitably a first step. This reality is reflected in the fact that not all participating countries have elected to take part in the administration of the electronic reading assessment in PISA 2009, which has therefore been implemented as an international option. The assessment of electronic reading will be reviewed and refined over successive cycles to keep pace with developing technologies, assessment tools and conceptual understanding of the electronic medium's impact.

Changes in our concept of reading since 2000 have already led to an expanded definition of reading literacy, which recognises motivational and behavioural characteristics of reading alongside cognitive characteristics. Both reading engagement and metacognition – an awareness and understanding of how one thinks and uses thinking strategies – were referred to briefly at the end of the first PISA framework for reading under "Other issues" (OECD, 1999). In the light of recent research, reading engagement and metacognition are featured more prominently in this PISA 2009 reading framework as elements that can make an important contribution to policy makers' understanding of factors that can be developed, shaped and fostered as components of reading literacy.

THE STRUCTURE OF THE READING LITERACY FRAMEWORK

This chapter addresses what is meant by the term reading literacy in PISA, and how it will be measured in PISA 2009. This section introduces the importance of reading literacy in today's societies. The second section defines reading literacy and elaborates on various phrases that are used in the reading framework, along with the assumptions underlying the use of these words. The third section focuses on the organisation of the domain of the assessment of reading literacy, and discusses the characteristics that will be represented in the tasks included in the PISA 2009 assessment. The fourth section discusses some of the operational aspects of the

assessment. The fifth section describes the theoretical basis for the constructs of engagement and metacognition in the context of reading, and outlines approaches for measuring those constructs. Finally, the last section describes how the reading literacy data will be summarised and outlines plans for reporting.

Reading literacy as a foundational skill

We live in a rapidly changing world, where both the quantity and type of written materials are increasing and where more and more people are expected to use these materials in new and sometimes more complex ways. It is now generally accepted that our understanding of reading literacy evolves along with changes in society and culture. The reading literacy skills needed for individual growth, economic participation and citizenship 20 years ago were different from those of today; and it is likely that in 20 years time they will change further still.

The goal of education has shifted its emphasis from the collection and memorisation of information only, to the inclusion of a broader concept of knowledge: The meaning of knowing has shifted from being able to remember information, to being able to find and use it" (Simon, 1996). The ability to access, understand and reflect on all kinds of information is essential if individuals are to be able to participate fully in our knowledge-based society. The PISA framework for assessing the reading literacy of students towards the end of compulsory education, therefore, must focus on reading literacy skills that include finding, selecting, interpreting and evaluating information from the full range of texts associated with situations that reach beyond the classroom.

According to Holloway (1999), reading skills are essential to the academic achievement of middle- and high-school students. Olson (1977a; 1977b) claims that in today's society, reading literacy introduces a bias because it provides advantages to those who acquire the necessary skills. As the currency used in schools, literacy provides access to literate institutions and has an impact on cognition, or thinking processes (Olson, 1994); it also shapes the way in which we think.

Achievement in reading literacy is not only a foundation for achievement in other subject areas within the educational system, but also a prerequisite for successful participation in most areas of adult life (Cunningham & Stanovich, 1998; Smith, Mikulecky, Kibby, & Dreher, 2000).

Today, the need for higher levels of education and skills is large and growing. Those with below average skills find it increasingly difficult to earn above average wages in global economies where the restructuring of jobs favours those who have acquired higher levels of education and skills. They have little hope of fully participating in increasingly complex societies where individuals are required to take on additional responsibility for different aspects of their lives: from planning their careers, to nurturing and guiding their children, to navigating health-care systems, to assuming more responsibility for their financial future. The non-economic returns from literacy in the form of enhanced personal well-being and greater social cohesion are as important as the economic and labour-market returns, according to some authorities (Friedman, 2005; OECD, 2001). Elwert (2001) has advanced the concept of societal literacy , referring to the way in which literacy is fundamental in dealing with the institutions of a modern bureaucratic society. Law, commerce and science use written documents and written procedures such as laws, contracts and publications that one has to be able to understand in order to function in these domains. The European Commission (2001) summed up the foundational nature of reading literacy skills as key to all areas of education and beyond, facilitating participation in the wider context of lifelong learning and contributing to individuals' social integration and personal development".More recently, the European Union endorsed this statement with its enshrinement of communication in the mother tongue, comprising listening, speaking, reading and writing, as the first of eight key compentencies "which all individuals need for personal fulfilment and development, active citizenship, social inclusion and employment" (Education Council, 2006).

Reading literacy skills matter not just for individuals, but for economies as a whole. Policy makers and others are coming to recognise that in modern societies, human capital – the sum of what the individuals in an economy know and can do – may be the most important form of capital. Economists have for many years developed models showing generally that a country's education levels are a predictor of its economic growth potential. Although the strength of this link is limited by the fact that an educational credential means something different from one country to another, international surveys such as the International Adult Literacy Survey (IALS) or the upcoming OECD Programme for the International Assessment of Adult Competencies (PIAAC) now let us

measure adults' literacy skills directly and not just through their credentials. These surveys, in turn, allow us to make more credible inferences about the connection between human capital and national economic growth. In a recent study, several Canadian economists analysed links between literacy levels and economic performance over a long period. They found that the average literacy level of a nation's population is a better predictor of economic growth than educational achievement (Coulombe, Trembly, & Marchand, 2004).

The importance of electronic texts

Proficiency in reading literacy is a key not only to unlocking the world of printed text, but also electronic texts, which are becoming an increasingly important part of students' and adults' reading. As of 2007, almost 1.5 billion people – one-fifth of the world's population – were reading on line (International Telecommunications Union, 2009). The rate of growth in online use has been staggering, with much of it having occurred during the past five years – though the rate varies widely according to location (The World Bank, 2007). The variation is not only geographical, but also social and economic. In all countries, Internet use is closely linked with socio-economic status and education (Sweets & Meates, 2004). Yet the requirement to use computers is not confined to particular social and economic strata. The Adult Literacy and Life Skills Survey (OECD and STATCAN, 2005) looked at computer use by type of occupation in seven countries or regions. While "expert" knowledge workers such as scientists and computing professionals use computers most intensively in the workplace, office workers and customer service clerks are also likely to need to use computers on the job. Therefore workers in a wide range of occupations are increasingly required to use computers as part of their jobs.

Beyond the workplace, computer technology has a growing importance in personal, social and civic life. To stay informed and involved, accessing information via networked computer technologies is becoming the norm. As individuals take on more responsibility for health, retirement and finance decisions, these technologies become increasingly important sources of information. Those with access to the Internet and with the skills and knowledge to use it effectively are more likely to become empowered patients who can make informed health-care choices; active citizens who use e-mail to influence government officials' policy decisions or mobilise like-minded voters; and members of virtual communities who, via online support groups, use instant messaging and discussion boards to interact with others across social classes, racial groups and generations (Pew Internet & American Life Project, 2005).

While many of the skills required for print and electronic reading are similar, electronic reading demands that new emphases and strategies be added to the repertoires of readers. Gathering information on the Internet requires skimming and scanning through large amounts of material and immediately evaluating its credibility. Critical thinking, therefore, has become more important than ever in reading literacy (Halpern, 1989; Shetzer & Warschauer, 2000; Warschauer, 1999). Warschauer concludes that overcoming the "digital divide" is not only a matter of achieving online access, but also of enhancing people's abilities to integrate, evaluate and communicate information.

Motivational and behavioural elements of reading literacy

Reading-related skills, attitudes, interests, habits and behaviours have been shown in a number of recent studies to be strongly linked with reading proficiency. For example, in PISA 2000 there was a greater correlation between reading proficiency and reading engagement (comprising attitudes, interests and practices) than between reading proficiency and socio-economic status (OECD, 2002). In other studies reading engagement has been shown to account for more variance in reading achievement than any other variable besides previous achievement (Guthrie & Wigfield, 2000).

Like reading engagement, metacognition has long been considered to be related to reading achievement (Brown, Brown, *et al*. 1983; Flavell & Wellman, 1977; Schneider, 1989, 1999; Schneider & Pressley, 1997), but most studies of metacognition have been largely experimental and focused on young readers. The PISA 2000 reading framework alluded to the potential for using PISA to collect information about metacognition relevant to policy makers, but concluded that in the absence of an existing instrument suitable for use in a large-scale study, metacognition could not be part of the reading literacy study in 2000 (OECD, 1999). Since then, such instrumentation has been developed (Artelt, Schiefele, & Schneider, 2001; Schlagmüller & Schneider, 2006) making the inclusion of a survey of metacognition in reading within PISA 2009 feasible.

There is evidence that skills relating to engagement and metacognition can be taught. Interest in measuring both metacognition and engagement as part of PISA 2009 therefore assumes that results can yield information that will be highly relevant to policy makers and that can also influence the practice of reading and learning and ultimately levels of reading proficiency.

DEFINING READING LITERACY

Definitions of reading and reading literacy have changed over time in parallel with changes in society, economy, and culture. The concept of learning, and particularly the concept of lifelong learning, have expanded the perception of reading literacy. Literacy is no longer considered an ability acquired only in childhood during the early years of schooling. Instead it is viewed as an expanding set of knowledge, skills and strategies that individuals build on throughout life in various contexts, through interaction with their peers and the wider community.

Cognitively-based theories of reading literacy emphasise the interactive nature of reading and the constructive nature of comprehension, in the print medium (Binkley & Linnakylä, 1997; Bruner, 1990; Dole, Duffy, Roehler, & Pearson, 1991) and to an even greater extent in the electronic medium (Fastrez, 2001; Legros & Crinon, 2002; Leu, 2007; Reinking, 1994). The reader generates meaning in response to text by using previous knowledge and a range of text and situational cues that are often socially and culturally derived. While constructing meaning, the reader uses various processes, skills, and strategies to foster, monitor, and maintain understanding. These processes and strategies are expected to vary with context and purpose as readers interact with a variety of continuous and non-continuous texts in the print medium and (typically) with multiple texts in the electronic medium.

The PISA 2000 definition of reading literacy is as follows:

> Reading literacy is understanding, using and reflecting on written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society.

The PISA 2009 definition of reading adds engagement in reading as an integral part of reading literacy:

> Reading literacy is understanding, using, reflecting on and engaging with written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society.

Each part of the definition is considered in turn below, taking into account the original elaboration and some important developments in the defining of the domain which use evidence from PISA and other empirical studies, from theoretical advances and from the changing nature of the world.

Reading literacy . . .

The term "reading literacy" is preferred to "reading" because it is likely to convey to a non-expert audience more precisely what the survey is measuring. "Reading" is often understood as simply decoding, or even reading aloud, whereas the intention of this survey is to measure something broader and deeper. Reading literacy includes a wide range of cognitive competencies, from basic decoding, to knowledge of words, grammar and larger linguistic and textual structures and features, to knowledge about the world. It also includes metacognitive competencies: the awareness of and ability to use a variety of appropriate strategies when processing texts. Metacognitive competencies are activated when readers think about, monitor and adjust their reading activity for a particular goal.

Historically, the term literacy referred to a tool used to acquire and communicate writtten and printed information. This seems close to the notion that the term "reading literacy" is intended to express in this study: the active, purposeful and functional application of reading in a range of situations and for various purposes. PISA assesses a wide range of students. Some of these students will go on to a university, possibly to pursue an academic career; some will pursue further studies in preparation for joining the labour force; and some will enter the workforce directly upon completion of school education. Regardless of their academic or labour-force aspirations, reading literacy will be important to their active participation in their community and economic and personal life.

. . is understanding, using, reflecting on . . .

The word understanding is readily connected with reading comprehension , a well-accepted element of reading. The word "using" refers to the notions of application and function – doing something with what we

read. "Reflecting on" is added to "understanding" and "using" to emphasise the notion that reading is interactive: readers draw on their own thoughts and experiences when engaging with a text. Of course, every act of reading requires some reflection, drawing on information from outside the text. Even at the earliest stages, readers draw on symbolic knowledge to decode a text and require a knowledge of vocabulary to make meaning. As readers develop their stores of information, experience and beliefs, they constantly, often unconsciously, test what they read against outside knowledge, thereby continually reviewing and revising their sense of the text. At the same time, incrementally and perhaps imperceptibly, readers' reflections on texts may alter their sense of the world. Reflection might also require readers to consider the content of the text, apply their previous knowledge or understanding, or think about the structure or form of the text.

As it is not possible to include sufficient items from the PISA assessment to report on each of the five aspects as a separate subscale, for reporting on reading literacy, these five aspects are organised into three broad aspect categories. In PISA 2000, PISA 2003 and PISA 2006 these three broad aspects were called "Retrieving information", "Interpreting texts" and "Reflecting and evaluating" respectively. The terms have been changed for PISA 2009 to better accommodate the aspects in relation to electronic texts.

. . . and engaging with . . .

A reading literate person not only has the skills and knowledge to read well, but also values and uses reading for a variety of purposes. It is therefore a goal of education to cultivate not only proficiency but also engagement in reading. Engagement in this context implies the motivation to read and is comprised of a cluster of affective and behavioural characteristics that include an interest in and enjoyment of reading, a sense of control over what one reads, involvement in the social dimension of reading, and diverse and frequent reading practices.

. . . written texts . . .

The phrase "written texts" is meant to include all those coherent texts in which language is used in its graphic form: hand-written, printed and electronic. These texts do not include aural language artefacts such as voice recordings; nor do they include film, TV, animated visuals, or pictures without words. They do include visual displays such as diagrams, pictures, maps, tables, graphs and comic strips, which include some written language (for example, captions). These visual texts can exist either independently or they can be embedded in larger texts. "Hand-written texts" are mentioned for completeness: although they are clearly part of the universe of written texts, they are not very different from printed texts in structure or in terms of the processes and reading strategies they require. Electronic texts, on the other hand, are distinguished from printed texts in a number of respects, including physical readability; the amount of text visible to the reader at any one time; the way different parts of a text and different texts are connected with one another through hypertext links; and consequent upon all these text characteristics, the way that readers typically engage with electronic texts. To a much greater extent than with printed or hand-written texts readers need to construct their own pathways to complete any reading activity associated with an electronic text.

Instead of the word "information", which is used in some other definitions of reading, the term "texts" was chosen because of its association with written language and because it more readily connotes literary as well as information-focused reading.

. . . in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society.

This phrase is meant to capture the full scope of situations in which reading literacy plays a role, from private to public, from school to work, from formal education to lifelong learning and active citizenship. To achieve one's goals and to develop one's knowledge and potential" spells out the idea that reading literacy enables the fulfilment of individual aspirations – both defined ones such as graduating or getting a job, and those less defined and less immediate which enrich and extend personal life and lifelong education. The word "participate" is used because it implies that reading literacy allows people to contribute to society as well as to meet their own needs: "participating" includes social, cultural, and political engagement. Literate people, for example, find it easier to navigate complex institutions such as health systems, government offices and legal agencies; and they can participate more fully in a democratic society by making informed decisions when they vote. Participation may also include a critical stance, a step for personal liberation, emancipation, and empowerment (Linnakylä, 1992; Lundberg, 1991, 1997; MacCarthey & Raphael, 1989).

Fifty years ago in his seminal work *Maturity in Reading* Gray wrote of the interests, attitudes and skills that enable young people and adults to meet effectively the reading demands of their current lives (Gray & Rogers, 1956). The PISA concept of reading literacy is consistent with Gray's broad and deep notion of maturity in reading, while simultaneously embracing the new challenges of reading in the 21st century. It conceives reading as the foundation for full participation in the economic, political, communal and cultural life of contemporary society.

ORGANISING THE DOMAIN

The previous section defined the domain of reading literacy and laid out the set of assumptions that were made in constructing this definition. This section describes how the domain is represented, a vital issue because the organisation and representation of the domain determines the test design and, ultimately, the evidence about student proficiencies that can be collected and reported.[1]

Reading is a multidimensional domain. While many elements are part of the construct, not all can be taken into account and manipulated in an assessment such as PISA. In designing an assessment it is necessary to select the elements considered most important to manipulate in building the assessment.

For PISA, the two most important considerations are firstly, to *ensure broad coverage* of what students read and for what purposes they read, both in and outside of school; and secondly, to organise the domain to *represent a range of difficulty*. The PISA reading literacy assessment is built on three major task characteristics: *situation* – the range of broad contexts or purposes for which reading takes place; *text* – the range of material that is read; and *aspect* – the cognitive approach that determines how readers engage with a text. All three contribute to ensuring *broad coverage* of the domain. In PISA, features of the text and aspect variables (but not of the situation variable) are also manipulated to influence the *difficulty* of a task.

In order to use these three main task characteristics in designing the assessment and, later, interpreting the results, they must be operationalised. That is, the various values that each of these characteristics can take on must be specified. This allows test developers to categorise the materials they are working with and the tasks they construct so that they can then be used to organise the reporting of the data and to interpret results.

Reading is a complex activity; the components of reading therefore do not exist independently of one another in neat compartments. The assignment of texts and tasks to framework categories does not imply that the categories are strictly partitioned or that the materials exist in atomised cells determined by a theoretical structure. The framework scheme is provided to ensure coverage, to guide the development of the assessment and to set parameters for reporting, based on what are considered the marked features of each task.

Situation

A useful operationalisation of the situation variables is found in the Common European Framework of Reference (CEFR) developed for the Council of Europe (Council of Europe, 1996). Although this framework was originally intended to describe second- and foreign- language learning, in this respect at least it is relevant to mother-tongue language assessment as well. The CEFR situation categories are: reading for private use; reading for public use; reading for work and reading for education. They have been adapted for PISA to personal, public, occupational and educational contexts, and are described in the paragraphs below.

The *personal* category relates to texts that are intended to satisfy an individual's personal interests, both practical and intellectual. This category also includes texts that are intended to maintain or develop personal connections with other people. It includes personal letters, fiction, biography, and informational texts that are intended to be read to satisfy curiosity, as a part of leisure or recreational activities. In the electronic medium it includes personal e-mails, instant messages and diary-style blogs.

The *public* category describes the reading of texts that relate to activities and concerns of the larger society. The category includes official documents as well as information about public events. In general, the texts associated with this category assume a more or less anonymous contact with others; they also therefore include forum-style blogs, news websites and public notices that are encountered both on line and in print.

The content of *educational* texts is usually designed specifically for the purpose of instruction. Printed text books and interactive learning software are typical examples of material generated for this kind of reading. Educational reading normally involves acquiring information as part of a larger learning task. The materials are often not chosen by the reader, but instead assigned by an instructor. The model tasks are those usually identified as "reading to learn" (Sticht, 1975; Stiggins, 1982).

Many 15-year-olds will move from school into the labour force within one to two years. A typical *occupational* reading task is one that involves the accomplishment of some immediate task. It might include searching for a job, either in a print newspaper's classified advertisement section, or on line; or following workplace directions. The model tasks of this type are often referred to as "reading to do" (Sticht, 1975; Stiggins, 1982). Texts written for these purposes, and the tasks based on them, are classified as occupational in PISA. While only some of the 15-year-olds who are assessed will currently have to read at work, it is important to include tasks based on texts that are related to work since the assessment of young people's readiness for life beyond compulsory schooling and their ability to use their knowledge and skills to meet real-life challenges is a fundamental goal of PISA.

Situation is used in PISA reading literacy to define texts and their associated tasks, and refers to *the contexts and uses for which the author constructed the text*. The manner in which the situation variable is specified is therefore about supposed audience and purpose, and is not simply based on the place where the reading activity is carried out. Many texts used in classrooms are not specifically designed for classroom use. For example, a piece of literary text may typically be read by a 15-year-old in a mother-tongue language or literature class, yet the text was written (presumably) for readers' personal enjoyment and appreciation. Given its original purpose, such a text is classified as *personal* in PISA. As Hubbard (1989) has shown, some kinds of reading usually associated with out-of-school settings for children, such as rules for clubs and records of games, often take place unofficially at school as well. These texts are classified as *public* in PISA. Conversely, textbooks are read both in schools and in homes, and the process and purpose probably differ little from one setting to another. Such texts are classified as *educational* in PISA.

It should be noted that the four categories overlap. In practice, for example, a text may be intended both to delight and to instruct (personal and educational); or to provide professional advice which is also general information (occupational and public). While content is not a variable that is specifically manipulated in this study, by sampling texts across a variety of situations the intent is to maximise the diversity of content that will be included in the PISA reading literacy survey.

One obvious way to distribute the reading literacy tasks in the assessment would be to do so evenly across the four situations. In the PISA 2000 framework however the occupational situation is given less weight for two reasons. First, it was considered important to reduce the potential dependence on specific occupational knowledge that can result when selecting occupational texts. Second, it was expected that the same type of questions and directives could be constructed from texts classified in one of the other situations, where 15-year-old students might have better access to the content. These considerations remain relevant in 2009. The distribution of tasks by situation for PISA 2009 print reading is therefore very similar to that for 2000. Table 1.1 shows the approximate distribution of tasks by situation for print and electronic reading tasks. It should be noted that the percentages given here and in all other tables in this section are approximate only, as distribution of tasks according to framework variables is not final at the time of publication.

Table 1.1 **Approximate distribution of tasks by situation for PISA 2009**

Situation	% of total tasks PISA 2009: print	% of total tasks PISA 2009: electronic
Personal	30	30
Educational	25	15
Occupational	15	15
Public	30	40
TOTAL	100	100

Text

Reading requires material for the reader to read. In an assessment, that material – a text (or a set of texts) related to a particular task – must be coherent within itself. That is, the text must be able to stand alone without requiring additional material to make sense to the proficient reader.[2] While it is obvious that there are many different kinds of texts and that any assessment should include a broad range, it is not so obvious that there is an ideal categorisation of kinds of texts. The addition of electronic reading in the 2009 framework makes this issue still more complex. For PISA 2009 there are four main classifications:

1. Medium: print and electronic
2. Environment: authored and message-based
3. Text format: continuous, non-continuous, mixed and multiple
4. Text type: description, narration, exposition, argumentation, instruction and transaction

The classification of medium – print and electronic – is applied to each text as the broadest distinction. Below that classification, the text format and text type categories are applied to all texts, whether print or electronic. The environment classification, on the other hand, is only applicable to electronic-medium texts. Each of these characteristics is discussed below.

In addition to the four major text characteristics – medium, environment, text format and text type – some additional terms are used in the following sections to describe characteristics of both print and electronic texts.

Text object is a term used to describe the familiar names given to texts when we refer to them in everyday contexts: terms such as report, novel, play, timetable, home page or e-mail message. Text objects vary according to both medium and text format. For example, timetables occur as non-continuous texts in both print and electronic media; home pages occur only in the electronic medium; reports may appear in either medium and in a variety of text formats.

Text features are characteristics of the text-based information that students have to work with in a task. Text features include the number of texts or pages students need to read in order to respond to individual items, the length of the texts to be read, the linguistic complexity of the texts, and the assumed familiarity the students have with the topics presented.

Navigation tools and features help readers to negotiate their way into, around and across texts. Navigation tools and features are discussed below in the context of electronic-medium texts. They include navigation icons, scroll bars, tabs, menus, embedded hyperlinks, text search functions such as Find or Search, and global content representation devices such as site maps. Many navigation tools and features are intrinsic and unique to the electronic medium, and make up some of its defining characteristics. However like many of the other electronic text elements, navigation tools and features have parallels in the print medium. In print they include tables of contents, indexes, chapter and section headings, headers and footers, page numbers and footnotes.

Medium

An important major categorisation of texts, new in the PISA 2009 framework for reading literacy, is the classification by medium: print or electronic.

Print-medium text usually appears on paper in forms such as single sheets, brochures, magazines and books. The physical status of the printed text encourages (though it may not compel) the reader to approach the content of the text in a particular sequence. In essence, printed texts have a fixed or static existence. Moreover, in real life and in the assessment context, the extent or amount of the text is immediately visible to the reader.

Electronic-medium text may be defined as the display of text through Liquid Crystal Display (LCD), plasma, Thin Film Transistor (TFT) and other electronic devices. For the purposes of PISA, however, electronic text is synonymous with *hypertext*: a text or texts with navigation tools and features that make possible and indeed even require non-sequential reading. Each reader constructs a "customised" text from the information encountered at the links he or she follows. In essence, such electronic texts have an unfixed, dynamic existence. In the electronic medium, typically only a fraction of the available text can be seen at any one time, and often the extent of text available is unknown.

Figure 1.1 ■ **Print reading texts in PISA**

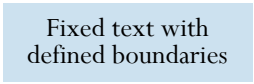
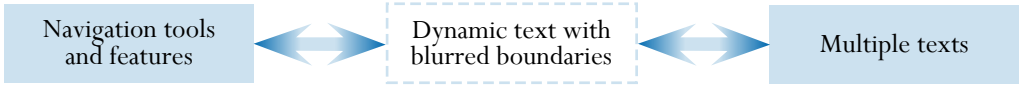


Figure 1.2 ■ **Electronic reading texts in PISA**



The difference between texts in the print and electronic media, in the PISA assessment context, is illustrated in Figure 1.1 and Figure 1.2.

Navigation tools and features play a particularly important role in the electronic medium, for at least two reasons. Firstly, due to the reduced display size, electronic texts come with devices that let the reader move the reading window over the text page: scroll bars, buttons, index tabs and so forth. Skilled readers of electronic text must be familiar with the use of these devices. They must also be able to mentally represent the movement of the window over the text page, and the shifting from one window to another. Secondly, typical electronic reading activities involve the use of multiple texts, sometimes selecting from a virtually infinite pool. Readers must be familiar with the use of retrieval, indexing and navigation tools for linking between texts.

One of the earliest indexing techniques used in electronic documents was the menu or list of page headings from which the reader is invited to choose. The electronic menu resembles a table of contents except that there are usually no page numbers. Instead, the reader selects an option by typing in its number in the menu or by clicking directly the menu option or a symbol that represents it. This results in the display of the pages instead of, or sometimes (in multi-window displays) on top of, the menu page. A consequence of the lack of page numbers is that once the page is displayed, the reader has no direct clue about its position among the set that makes up the electronic book. Sometimes such clues are provided through analogical symbols (for example, a micro-page within a series of micro-pages at the bottom of the screen) or through path-type expressions. Menus can be made hierarchical, which means that selecting a menu item causes another, more specific menu to be displayed. Menus may be presented as separate pages, but they may also be presented as part of multi-text pages. They are often presented in a frame to the left of the display window. The rest of the window can be updated with the menu remaining constant, which is considered helpful for the reader to keep a sense of his or her "location" in the document. Skilled reading of electronic texts therefore requires an understanding of hierarchical and straight-list menus, as well as an ability to mentally represent non-sequential page arrangements, whether hierarchical or networked.

A major navigation tool that assists readers in finding their way around a number of texts, and one of the most distinctive features of electronic texts, is the hypertext link, a technique that appeared in the 1980s as a means to connect units of information in large electronic documents (Conklin, 1987; Koved & Shneiderman, 1986; Lachman, 1989; Weyer, 1982). The hypertext link or hyperlink is a piece of information (a word or phrase, or a picture or icon) that is logically connected to another piece of information (usually a page). Clicking a hyperlink results in the display of a new page instead of or on top of the page previously displayed, or the display of another location on the same page. Hyperlinks may be presented in separate lists (also called menus) or embedded within content pages. When embedded, hyperlinks are generally marked using a specific colour or typography. The use of hyperlinks allows the creation of multi-page documents with a networked structure. Unlike lists or hierarchies, the arrangement of pages in a networked structure is not regularised according to a systematic set of conventions. Rather, it follows the semantic relationships across pages. It is up to the author of a multi-page electronic document to determine how the pages are linked, through the insertion of hyperlinks.

Navigation and orientation within non-sequential structures seem to rely on the reader's ability to mentally represent the top-level structure of the hypertext. Global organisers that accurately represent the structure of pages and links (for example, structured menus and content maps) are usually of some help, provided that such organisers use symbols and metaphors that are already familiar to the reader (Rouet & Potelle, 2005).

Skilled reading, navigation and information search in hypertext requires the reader to be familiar with explicit and embedded hyperlinks, non-sequential page structures, and global content representation devices.

In the PISA 2009 assessment of electronic reading (ERA), a set of navigation tools and structures have been identified for systematic inclusion in the instruments, as one important component in measuring proficiency in electronic reading. This set includes scroll bars for moving up and down a page; tabs for different websites; lists of hyperlinks displayed in a row, in a column or as a drop-down menu; and embedded hyperlinks – that is, hyperlinks included in paragraphs, tables of information or a list of search results. Hyperlinks may take the form of icons or words.

The difficulty of a task is partly conditioned by the navigation tools and features associated with it. Tasks are more or less easy depending on the number of navigation tools that are required to be used, the number of operations or steps required, and the type of tools used. Generally, the larger the number of operations, and the more complex the tool type, the greater the item difficulty. The familiarity, transparency or prominence of navigation tools and features also affects difficulty. For example, a hyperlink labelled "click here" is typically easier to navigate than a drop down menu that only displays itself if the cursor passes over it. Some electronic reading tasks require little or even no navigation: for example, when students are required to locate or interpret information on a web page where the text is fully visible.

Environment

The *environment* classification is a new variable for the PISA 2009 reading framework. In PISA it applies only to electronic-medium texts.

Electronic texts exist in a number of environments, including the web environment, desktop and e-mail. There are other electronic environments that use written text such as mobile phone text messages and electronic diaries. For the purposes of PISA 2009, however, only computer-based environments are considered.

Two broad kinds of electronic environment have been identified for the assessment of reading of electronic texts. The distinction between them is based on whether or not the reader has the potential to influence the content of the site. An *authored* environment is one in which the reader is primarily receptive: the content cannot be modified. A *message-based* environment is one in which the reader has the opportunity to add to or change the content.

Texts in an *authored environment* have a fixed content that cannot be influenced by the reader. They are self-contained environments, controlled or published by a commercial company, a government department, an organisation or institution, or an individual. Readers use these sites mainly for obtaining information. Text objects within an authored environment include home pages, sites publicising events or goods, government information sites, educational sites containing information for students, news sites and online library catalogues.

In a *message-based environment*, on the other hand, the reader is invited to participate and contribute in some way. The content is to some extent fluid or collaborative, in that it can be added to or changed in some way by individuals. Readers use these sites not only for obtaining information, but also as a way of communicating. Text objects within a message-based environment include e-mail, blogs, chat rooms, web forums and reviews, and online forms.

Inevitably, the possible range of text object categories within each of the electronic environments is not completely represented given the limited number of tasks in the PISA 2009 instrument. Instead the assessment comprises a sample of the text objects likely to be encountered by 15-year-olds and young adults in educational, occupational, personal, and public contexts.

As with many of the variables in the reading framework, the environment classifications are not strictly partitioned. A given website, for example, may include some authored text and a section in which the reader is invited to add a comment. Nevertheless, an individual task generally draws predominantly upon either an authored or a message-based part of the stimulus, and is classified acccordingly. Occasionally a task may require integrated use of both authored and message-based texts. Such tasks are classified as *mixed*. Table 1.2 shows the proportion of tasks in each environment category.

Table 1.2 **Approximate distribution of electronic tasks by environment**

Environment	% tasks in electronic reading assessment
Authored	70
Message-based	25
Mixed	5
TOTAL	100

The authored and message-based environments are not considered hierarchical in difficulty; nor are they intended to form the basis for reporting subscales. The distribution of tasks across the two broad environments has been used primarily to guide test development so that a range of reading situations is covered that is relevant to 15-year-olds both in and beyond school.

Text format

An important classification of texts, and one at the heart of the organisation of the PISA 2000 framework and assessment, is the distinction between continuous and non-continuous texts. Continuous texts are typically composed of sentences that are, in turn, organised into paragraphs. These may fit into even larger structures such as sections, chapters, and books. Non-continuous texts are most frequently organised in matrix format, based on combinations of lists.

Texts in continuous and non-continuous format appear in both the print and electronic media. Mixed and multiple format texts are also prevalent in both media, particularly so in the electronic medium. Each of these four formats is elaborated below.

Other non-text formatted objects are also commonly used in conjunction with print and particularly with electronic texts. Pictures and graphic images occur frequently in print texts and can legitimately be regarded as integral to such texts. Static images as well as videos, animations and audio files regularly accompany electronic texts and can, also, be regarded as integral to those texts. As a reading literacy assessment, PISA does not focus on non-text formatted objects independently, but any such objects may, in principle, appear in PISA as part of a (verbal) text. However in practice the use of video and animation is very limited in the current assessment. Audio is not used at all because of practical limitations such as the need for headphones and audio translation.

Continuous texts

Continuous texts are formed by sentences organised into paragraphs.

Graphically or visually, organisation occurs by the separation of parts of the text into paragraphs, by paragraph indentation, and by the breakdown of text into a hierarchy signalled by headings that help readers to recognise the organisation of the text. These markers also provide clues to text boundaries (showing section completion, for example). The location of information is often facilitated by the use of different font sizes, font types such as italic and boldface, or borders and patterns. The use of format clues is an essential subskill of effective reading.

Discourse markers also provide organisational information. Sequence markers (first, second, third, etc.), for example, signal the relation of each of the units introduced to each other and indicate how the units relate to the larger surrounding text. Causal connectors (therefore, for this reason, since, etc.) signify cause-effect relationships between parts of a text.

Examples of text objects in continuous text format in the print medium include newspaper reports, essays, novels, short stories, reviews and letters. In the electronic medium the continuous text format group includes reviews, blogs and reports in prose. Electronic continuous texts tend to be short because of the limitations of screen size and the need for piecemeal reading, which make long texts unattractive to many online readers.

Non-continuous texts

Non-continuous texts, also known as documents, are organised differently to continuous texts, and therefore require a different kind of reading approach. As the sentence is the smallest unit of continuous text, so all non-continuous texts can be shown to be composed of a number of lists (Kirsch & Mosenthal, 1990). Some are single, simple lists, but most consist of several simple lists combined. This analysis of non-continuous texts does not refer to their use or employ the common labels often attached to them, but does identify key structural features that are common to a number of different texts. Readers who understand the structure of texts are better able to identify the relationships between the elements and understand which texts are similar and which are different.

Examples of non-continuous text objects are lists, tables, graphs, diagrams, advertisements, schedules, catalogues, indexes and forms. These text objects occur in both print and electronic media.

The following two text format categories are new in the 2009 framework. Recognition of the importance of integrating information in different formats and across several texts, as part of the reader's repertoire, has led to the identification of *mixed* and *multiple* texts as distinct text formats.

Mixed texts

Many texts in both print and electronic media are single, coherent objects consisting of a set of elements in both a continuous and non-continuous format. In well-constructed mixed texts the components (for example, a prose explanation including a graph or table) are mutually supportive through coherence and cohesion links at the local and global level.

Mixed text in the print medium is a common format in magazines, reference books and reports, where authors employ a variety of presentations to communicate information. In the electronic medium authored web pages are typically mixed texts, with combinations of lists, paragraphs of prose and often graphics. Message-based texts such as online forms, e-mail messages and forums also combine texts that are continuous and non-continuous in format.

Multiple texts

For the purposes of the PISA reading framework multiple texts are defined as those which have been generated independently, and make sense independently; they are juxtaposed for a particular occasion or may be loosely linked together for the purposes of the assessment. The relationship between the texts may not be obvious; they may be complementary or may contradict one another. For example, a set of websites from different companies providing travel advice may or may not provide similar directions to tourists. Multiple texts may have a single "pure" format (for example, continuous), or may include both continuous and non-continuous texts.

Tasks in the print-medium assessment continue to be classified for the most part as either continuous or non-continuous, with about two-thirds of such tasks addressing continuous texts and one-third non-continuous texts. Although some mixed and multiple texts were used in the PISA 2000 assessment, they were not separately classified, but rather described in terms of their continuous or non-continuous elements. In the development of tasks for the PISA 2009 assessment there has been a more deliberate effort to include stimuli of mixed and multiple print texts, and to include tasks that require the reader to integrate information across differently formatted parts within a mixed text or across multiple texts. In previous administrations of PISA the few tasks that required integration within mixed texts or across multiple texts were classified according to text format on the basis of what was judged to be the part of the stimulus (continuous or non-continuous) that was the object of the more significant processing. The introduction of four categories of text format allows the still relatively small number of print-based tasks that require integration of information across formats or across texts to be classified respectively as *mixed* or *multiple*.

Table 1.3 **Approximate distribution of tasks by text format for PISA**

Text format	% of total tasks PISA 2009: print	% of total tasks PISA 2009: electronic
Continuous	60	10
Non-continuous	30	10
Mixed	5	10
Multiple	5	70
TOTAL	100	100

In comparison, in the electronic-medium assessment, the proportion of tasks based on multiple texts is much greater. Given the focus of the electronic reading assessment on hypertext, in almost all units the stimulus will consist of multiple texts, and the tasks will require users to read across several texts (which may be different websites or different pages belonging to the same website), each presented in a variety of formats including prose paragraphs, menu lists, diagrams and other graphics. A large majority of tasks is therefore categorised as multiple texts for the text format variable. The relatively small numbers of tasks in the electronic reading assessment that require only local processing of single texts – whether they are continuous, non-continuous or mixed – are classified accordingly.

Text type

A different categorisation of text is by text type: description, narration, exposition, argumentation, instruction and transaction. In previous versions of the reading framework, these text types were located as subcategories of the continuous text format. In this new version it is acknowledged that non-continuous texts (and the elements of mixed and multiple texts) also have a descriptive, narrative, expository, argumentative or instructional purpose.

Texts as they are found in the world typically resist categorisation, as they are usually not written with text type rules in mind, and tend to cut across categories. For example, a chapter in a textbook might include some definitions (exposition), some directions on how to solve particular problems (instruction), a brief historical account of the discovery of the solution (narration), and descriptions of some typical objects involved in the solution (description). The distinctions in the electronic medium are even more blurred, especially in the web environment where the definition of where the text begins and ends is itself contestable, and any page of material typically includes not only a range of text types, but also different representations that may include words, images, animations, video and audio files. Nevertheless, in an assessment like PISA it is useful to categorise texts according to the text type, based on the predominant characteristics of the text, in order to ensure that the instrument samples across a range of texts that represent different types of reading.

The following classification of texts used in PISA is adapted from the work of Werlich (1976).

Description is the type of text where the information refers to properties of objects in space. The typical questions that descriptive texts provide an answer to are *what* questions. Descriptions can take several forms. Impressionistic descriptions present information from the point of view of subjective impressions of relations, qualities, and directions in space. Technical descriptions present information from the point of view of objective observation in space. Frequently, technical descriptions use non-continuous text formats such as diagrams and illustrations. Examples of text objects in the text type category description are a depiction of a particular place in a travelogue or diary, a catalogue, a geographical map, an online flight schedule or a description of a feature, function or process in a technical manual.

Narration is the type of text where the information refers to properties of objects in time. Narration typically answers questions relating to *when*, or *in what sequence*. Why characters in stories behave as they do is another important question that narration typically answers. Narration can take different forms. *Narratives* present change from the point of view of subjective selection and emphasis, recording actions and events from the point of view of subjective impressions in time. *Reports* present change from the point of view of an

objective situational frame, recording actions and events which can be verified by others. *News stories* intend to enable the readers to form their own independent opinion of facts and events without being influenced by the reporter's references to his own views. Examples of text objects in the text type category *narration* are a novel, a short story, a play, a biography, a comic strip, and a newspaper report of an event.

Exposition is the type of text in which the information is presented as composite concepts or mental constructs, or those elements into which concepts or mental constructs can be analysed. The text provides an explanation of how the different elements interrelate in a meaningful whole and often answers questions about *how*. Expositions can take various forms. *Expository essays* provide a simple explanation of concepts, mental constructs, or conceptions from a subjective point of view. *Definitions* explain how terms or names are interrelated with mental concepts. In showing these interrelations, the definition explains the meaning of words. *Explications* are a form of analytic exposition used to explain how a mental concept can be linked with words or terms. The concept is treated as a composite whole which can be understood by being broken down into constituent elements and their interrelations with each being given a name. *Summaries* are a form of synthetic exposition used to explain and communicate texts in a shorter form than the original text requires. *Minutes* are a record of the results of meetings or presentations. *Text interpretations* are a form of both analytic and synthetic exposition used to explain the abstract concepts which are realised in a particular (fictional or non-fictional) text or group of texts. Examples of text objects in the text type category *exposition* are a scholarly essay, a diagram showing a model of memory, a graph of population trends, a concept map and an entry in an online encyclopaedia.

Argumentation is the type of text that presents the relationship among concepts or propositions. Argument texts often answer *why* questions. An important subclassification of argument texts is persuasive and opinionative texts, referring to opinions and points of view. *Comment* relates the concepts of events, objects, and ideas to a private system of thoughts, values, and beliefs. *Scientific argumentation* relates concepts of events, objects, and ideas to systems of thought and knowledge so that the resulting propositions can be verified as valid or non-valid. Examples of text objects in the text type category *argumentation* are a letter to the editor, a poster advertisement, the posts in an online forum and a web-based review of a book or film.

Instruction (sometimes called injunction) is the type of text that provides directions on what to do. *Instructions* present directions for certain behaviours in order to complete a task. *Rules*, *regulations*, and *statutes* specify requirements for certain behaviours based on impersonal authority, such as practical validity or public authority. Examples of text objects in the text type category *instruction* are a recipe, a series of diagrams showing a procedure for giving first aid, and guidelines for operating digital software.

Transaction represents the kind of text that aims to achieve a specific purpose outlined in the text, such as requesting that something is done, organising a meeting or making a social engagement with a friend. Before the spread of electronic communication, this kind of text was a significant component of some kinds of letters and, as an oral exchange, the principal purpose of many phone calls. This text type was not included in Werlich's (1976) categorisation, used until now for the PISA framework.

The term transactional is used in PISA not to describe the general process of extracting meaning from texts (as in reader-response theory), but the type of text written for the kinds of purposes described here. Transactional texts are often personal in nature, rather than public, and this may help to explain why they do not appear to be represented in some of the corpora used to develop many text typologies. For example, this kind of text is not commonly found on websites, which are frequently the subject of corpus linguistics studies (for example, Santini, 2006). With the extreme ease of personal communication using e-mail, text messages, blogs and social networking websites, this kind of text has become much more significant as a reading text type in recent years. Transactional texts often build on common and possibly private understandings between communicators – though clearly, this feature is difficult to explore in a large-scale assessment. Examples of text objects in the text type transaction are everyday e-mail and text message exchanges between colleagues or friends that request and confirm arrangements.

Narration occupies a prominent position in many national and international assessments. Some texts are presented as being accounts of the world as it is (or was) and therefore claim to be factual or non-fictional. Fictional accounts bear a more metaphorical relation to the world as it is, appearing either as accounts of how it might be or of how it seems to be. In other large-scale reading studies, particularly those for school students: the National Assessment of Educational Progress (NAEP); the IEA Reading Literacy Study (IEARLS); and the IEA Programme in International Reading Literacy Study (PIRLS), the major classification of texts is between

fictional or literary texts, and non-fictional texts (*Reading for literary experience* and *Reading for information or to perform a task* in NAEP; *Literary experience* and *Acquire and use information* in PIRLS). This distinction is increasingly blurred as authors use formats and structures typical of factual texts in creating their fictions. The PISA reading literacy assessment includes both factual and fictional texts, and texts that may not be clearly one or the other. PISA however does not attempt to measure differences in reading proficiency between one type and the other. In PISA, fictional texts are classified as narration. The proportion of narrative texts in the print medium in PISA 2009 is similar to that in PISA 2000, at about 15%. Narratives in the electronic medium tend to be non-verbal, with animation and film having filled the position. There is therefore no specification for narrative in the electronic reading assessment.

Aspect

Whereas navigation tools and features are the visible or physical features that allow readers to negotiate their way into, around and between texts, *aspects* are the *mental* strategies, approaches or purposes that readers use to negotiate their way into, around and between texts.

Five aspects guide the development of the reading literacy assessment tasks:

- retrieving information
- forming a broad understanding
- developing an interpretation
- reflecting on and evaluating the content of a text
- reflecting on and evaluating the form of a text

As it is not possible to include sufficient items in the PISA assessment to report on each of the five aspects as a separate subscale, for reporting on reading literacy these five aspects are organised into three broad aspect categories:

- access and retrieve
- integrate and interpret
- reflect and evaluate

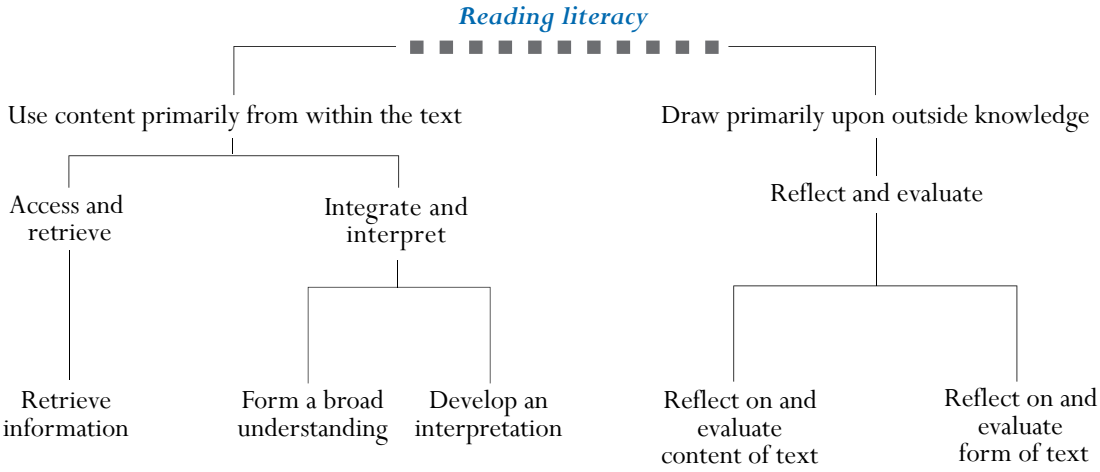
Retrieving information tasks, which focus the reader on separate pieces of information within the text, are assigned to the *access and retrieve* scale.

Forming a broad understanding and *developing an interpretation* tasks focus the reader on relationships within a text. Tasks that focus on the whole text require readers to form a broad understanding; tasks that focus on relationships between parts of the text require developing an interpretation. The two are grouped together under *integrate and interpret*.

Tasks addressing the last two aspects, *reflecting on the content of a text* and *reflecting on the form of a text*, are grouped together into a single *reflect and evaluate* aspect category. Both require the reader to draw primarily on knowledge outside the text and relate it to what is being read. *Reflecting on content* tasks are concerned with the notional substance of a text; *reflecting on form* tasks are concerned with its structure or formal features.

Figure 1.3 shows the relationship between the five aspects targeted in the test development and the three broad reporting aspects.

Figure 1.3 ■ **Relationship between the reading framework and the aspect subscales**



An elaboration of the three broad aspect categories, encompassing tasks in both print and electronic media, is given below.

Access and retrieve

Accessing and retrieving involves going to the information space provided and navigating in that space to locate and retrieve one or more distinct pieces of information. Access and retrieve tasks can range from locating the details required by an employer from a job advertisement, to finding a telephone number with several prefix codes, to finding a particular fact to support or disprove a claim someone has made.

In daily life, readers often need to retrieve information. To do so, readers must scan, search for, locate and select relevant information from some information space (for example, a page of continuous text, a table or a list of information). The required information is most frequently found in a single location, though in some cases the information may be in two or more sentences, in several cells of a table or in different parts of a list.

In assessment tasks that call for retrieving information, students must match information given in the question with either identically worded or synonymous information in the text and use this to find the new information called for. In these tasks, *retrieving information* is based on the text itself and on explicit information included in it. Retrieving tasks require the student to find information based on requirements or features explicitly specified in questions. The student has to detect or identify one or more essential elements of a question, such as characters, place/time and setting, and then to search for a match that may be literal or synonymous.

Retrieving tasks can involve various degrees of ambiguity. For example, the student may be required to select explicit information, such as an indication of time or place in a text or table. A more difficult version of this same type of task might involve finding synonymous information. This sometimes involves categorisation skills, or it may require discriminating between two similar pieces of information. Different levels of proficiency can be measured by systematically varying the elements that contribute to the difficulty of the task.

While *retrieving* describes the process of selecting the required information, *accessing* describes the process of getting to the place, the information space, where the required information is located. Some items may require retrieving information only, especially in the print medium where the information is immediately visible and where the reader only has to select what is appropriate in a clearly specified information space. On the other hand, some items in the electronic medium require little more than accessing: for example, clicking on an embedded link to open a web page (in a very limited information space), or clicking to select an item in a list of search results. However, both processes are involved in most *access and retrieve* tasks in PISA. In the print medium such items might require readers to use navigation features such as headings or captions to find their way to the appropriate section of the text before locating the relevant information. In the electronic medium

an *access and retrieve* item might involve navigating across several pages of a website, or using menus, lists or tabs to locate relevant information.

In both the print and electronic media, the process of accessing and retrieving information involves skills associated with selecting, collecting and retrieving information. Access and retrieve items in the electronic medium may additionally require students to navigate their way to a particular web page (for example) to find specified information, possibly using several navigation tools and traversing a number of pages. Students may be asked to click on a particular link or choose an item from a drop down menu. Examples include opening a website using a hyperlink; opening one or more new pages within a website; or scrolling down a page and clicking on a hyperlink. In accessing a particular item, students will need to make decisions about thematic interest. They will need to identify whether a link or site provides the information required, in terms of topical interest or relevance. Difficulty will be determined by several factors including the number of pages or links that need to be used, the amount of information to be processed on any given page, and the specificity and explicitness of the task directions.

Integrate and interpret

Integrating and interpreting involves processing what is read to make internal sense of a text.

Interpreting refers to the process of making meaning from something that is not stated. It may involve recognising a relationship that is not explicit or it may be required at a more local level to infer (to deduce from evidence and reasoning) the connotation of a phrase or a sentence. When interpreting, a reader is identifying the underlying assumptions or implications of part or all of the text. A wide variety of cognitive activities is included in this approach. For example, a task may involve inferring the connection between one part of the text and another, processing the text to form a summary of the main ideas, requiring an inference about the distinction between principal and subordinate elements, or finding a specific instance in the text of something earlier described in general terms.

Integrating focuses on demonstrating an understanding of the coherence of the text. It can range from recognising local coherence between a couple of adjacent sentences, to understanding the relationship between several paragraphs, to recognising connections across multiple texts. In each case, integrating involves connecting various pieces of information to make meaning, whether it be identifying similarities and differences, making comparisons of degree, or understanding cause and effect relationships.

Both interpreting and integrating are required to *form a broad understanding*. A reader must consider the text as a whole or in a broad perspective. Students may demonstrate initial understanding by identifying the main topic or message or by identifying the general purpose or use of the text. Examples include tasks that require the reader to select or create a title or assumption for the text, explain the order of simple instructions, or identify the main dimensions of a graph or a table. Others include tasks that require the student to describe the main character or setting of a story, to identify a theme of a literary text, or explain the purpose or use of a map or figure.

Within this aspect some tasks might require the student to identify a specific piece of text, when a theme or main idea is explicitly stated. Other tasks may require the student to focus on more than one part of the text – for instance, if the reader has to deduce the theme from the repetition of a particular category of information. Selecting the main idea implies establishing a hierarchy among ideas and choosing the one that is most general and overarching. Such a task indicates whether the student can distinguish between key ideas and minor details, or can recognise the main theme in a sentence or title.

Both interpreting and integrating are also involved in *developing an interpretation*, which requires readers to extend their initial broad impressions so that they develop a deeper, more specific or more complete understanding of what they have read. Many tasks in this category call for logical understanding: readers must process the organisation of information in the text. To do so, readers must demonstrate their understanding of cohesion even if they cannot explicitly state what cohesion is. In some instances, developing an interpretation may require the reader to process a sequence of just two sentences relying on local cohesion. This might even be facilitated by the presence of cohesive markers, such as the use of "first" and "second" to indicate a sequence. In more difficult instances (for example, to indicate relations of cause and effect), there might not be any explicit markings.

Other tasks include comparing and contrasting information, and identifying and listing supporting evidence. *Compare and contrast* tasks require the student to draw together two or more pieces of information from the text. In order to process either explicit or implicit information from one or more sources in such tasks, the reader must often infer an intended relationship or category.

As well as these integrative tasks, *developing an interpretation* tasks may involve drawing an inference from a more localised context: for example, interpreting the meaning of a word or phrase that gives a particular nuance to the text. This process of comprehension is also assessed in tasks that require the student to make inferences about the author's intention, and to identify the evidence used to infer that intention.

In traditional print environments, information might be located in a single paragraph, across different paragraphs or sections of text, or across two or more texts. In electronic environments, integration can be more complex. In a web environment, for example, information can be connected in a non-sequential way through a series of hyperlinks. While integration may take on increased complexity in electronic environments, those environments also provide tools that can facilitate the integration process. For example, views in a word processing program can be manipulated so that information in various locations can be viewed simultaneously, facilitating comparisons. Individuals take on an increased responsibility to know and understand which information can be used and which tools can be used to view it in order to facilitate the integration of information.

The way we synthesise information is also transformed in the electronic environment. We synthesise information in the print medium, of course, but typically this takes place within continuous text that has been constructed for us. Electronic reading is different in that readers actually construct the texts that they read by the choices they make in the links that they follow, collecting a series of texts and synthesising the essential aspects of each during the comprehension process. Synthesis is also different in that readers often skip more information than they read on any single page; the units of text that readers find useful on any single page are often quite small and they rarely read all of the information on a single web page.

An *integrate and interpret* task in the electronic medium may involve surfing several pages of a website or combining information from different sites, or it may require drawing inferences from information on a single page. As in print reading, tasks will include comparing, contrasting, finding evidence, determining influence, generalising and analysing subtleties of language. Difficulty will be determined by several factors including the number of pieces of information to be integrated and the number of locations where they are found, as well as the verbal complexity and the subject familiarity of the textual information.

As mentioned above, *interpreting* signifies the process of making meaning from something that is not explicitly stated. In recognising or identifying a relationship that is not explicit, an act of interpretation is required: thus interpretation is perhaps always involved somewhere in the process of *integration* as described above. The relationship between the processes of integration and interpretation may therefore be seen as intimate and interactive. Integrating involves first inferring a relationship within the text (a kind of interpretation), and then bringing pieces of information together, therefore allowing an interpretation to be made that forms a new integrated whole.

Reflect and evaluate

Reflecting and evaluating involves drawing upon knowledge, ideas or attitudes beyond the text in order to relate the information provided within the text to one's own conceptual and experiential frames of reference.

Reflect items may be thought of as those that require readers to consult their own experience or knowledge to compare, contrast or hypothesise. *Evaluate* items are those that ask readers to make a judgment drawing on standards beyond the text.

Reflecting on and evaluating the content of a text requires the reader to connect information in a text to knowledge from outside sources. Readers must also assess the claims made in the text against their own knowledge of the world. Often readers are asked to articulate and defend their own points of view. To do so, readers must be able to develop an understanding of what is said and intended in a text. They must then test that mental representation against what they know and believe on the basis of either prior information, or information found in other texts. Readers must call on supporting evidence from within the text and contrast it with other sources of information, using both general and specific knowledge as well as the ability to reason abstractly.

Assessment tasks representing this category of processing include providing evidence or arguments from outside the text, assessing the relevance of particular pieces of information or evidence, or drawing comparisons with moral or aesthetic rules (standards). The task might require a student to offer or identify alternative pieces of information to strengthen an author's argument, or evaluate the sufficiency of the evidence or information provided in the text.

The outside knowledge to which textual information is to be connected may come from the student's own knowledge or from ideas explicitly provided in the question. In the PISA context, any outside knowledge required is intended to be within the expected range of 15-year-olds' experiences. For example, it is assumed that 15-year-olds are likely to be familiar with the experience of going to the movies, a context that is drawn upon in the items related to the stimulus *Macondo*, discussed below.

Reflecting on and evaluating the form of a text requires readers to stand apart from the text, to consider it objectively and to evaluate its quality and appropriateness. Implicit knowledge of text structure, the style typical of different kinds of texts and register play an important role in these tasks. These features, which form the basis of an author's craft, figure strongly in understanding standards inherent in tasks of this nature. Evaluating how successful an author is in portraying some characteristic or persuading a reader depends not only on substantive knowledge but also on the ability to detect subtleties in language – for example, understanding when the choice of an adjective might influence interpretation.

Some examples of assessment tasks characteristic of *reflecting on and evaluating the form of a text* include determining the usefulness of a particular text for a specified purpose and evaluating an author's use of particular textual features in accomplishing a particular goal. The student may also be called upon to describe or comment on the author's use of style and to identify the author's purpose and attitude.

While the kinds of reflection and evaluation called for in the print medium assessment are also required in the electronic medium, evaluation in the electronic medium takes on a slightly different emphasis.

Printed texts are typically edited and filtered by many layers of the print publication process. On the web, however, anyone can publish anything. Moreover, the homogeneity of electronic text formats (windows, frames, menus, hyperlinks) tends to blur the distinctions across text types. These new features of electronic text increase the need for the reader to be aware of authorship, accuracy, quality and credibility of information. Whereas in the printed text clear indications of the source are usually available (for example, through the standard practice of mentioning author – sometimes with credentials, publisher, date and place of publication in the book), in electronic texts that important information is not always available. There is therefore a need for readers of electronic text to be more active in assessing and reasoning about source features. As people have access to a broadening universe of information in networked environments, evaluation takes on an increasingly critical role. While published print information carries a sense of legitimacy stemming from the assumed reviewing and editing process, sources for online information are more varied, ranging from authoritative sources to postings with unknown or uncertain authenticity. Such information must be evaluated in terms of accuracy, reliability and timeliness. It is important to recognise that the evaluation process happens continuously and therefore is a critical component of electronic reading. Once a reader has located information related to the question or problem, critical analysis of that information becomes important. While critical analysis of information takes place in the print medium, of course, it is even more important on line. Moreover, it is a skill that few adolescents appear to possess; they are easily fooled by false information appearing on the web and do not always possess strategies to analyse its accuracy (see for example Leu & Castek, 2006).

Skilled readers in the electronic medium know how to evaluate information that may be questionable. They also know how to use a search engine to gather additional information about a site by simply conducting a search for its title and additional words such as "hoax," "true?" or "accurate?" Critical analysis, a skill required during print reading comprehension, is transformed in important ways in the electronic medium, requiring new online reading skills. For instance, the availability of Internet resources in schools has encouraged teachers to include document search assignments in their instructional strategies. In order to complete those assignments, students need to be not only good at understanding what they read, but also at searching. This can be compared with a more traditional document-based teaching session where a single document would be pre-selected, copied and distributed by the teacher for in-depth reading and study.

Rieh (2002) identifies two distinct kinds of judgement that Internet users tend to make: predictive judgements and evaluative judgements. A *reflect and evaluate* item may involve making a predictive judgement about which site to go to from a range of possibilities, based on relevance, authenticity and authority. Once at a site, a reader completing a *reflect and evaluate* item may need to make an *evaluative* judgement: students may be asked to evaluate a site or link in terms of authority or reliability, credibility and trustworthiness of information. For example, they may need to assess whether the information is official and authoritative, unsupported personal opinion, or propaganda designed to influence the reader.

Some items may require reflection on and evaluation of the content of a site in similar ways to those currently used in print reading: for example, where students give a personal response to ideas and opinions, using background knowledge and experience. As with print assessment items, the difficulty of *reflect and evaluate* items is determined by several factors including the quantity and explicitness of information to support a reflection and evaluation and the extent to which the information is common knowledge.

To some extent every critical judgment requires the reader to consult his or her own experience; some kinds of reflection, on the other hand, do not require evaluation (for example, comparing personal experience with something described in a text). Thus evaluation might be seen as a subset of reflection.

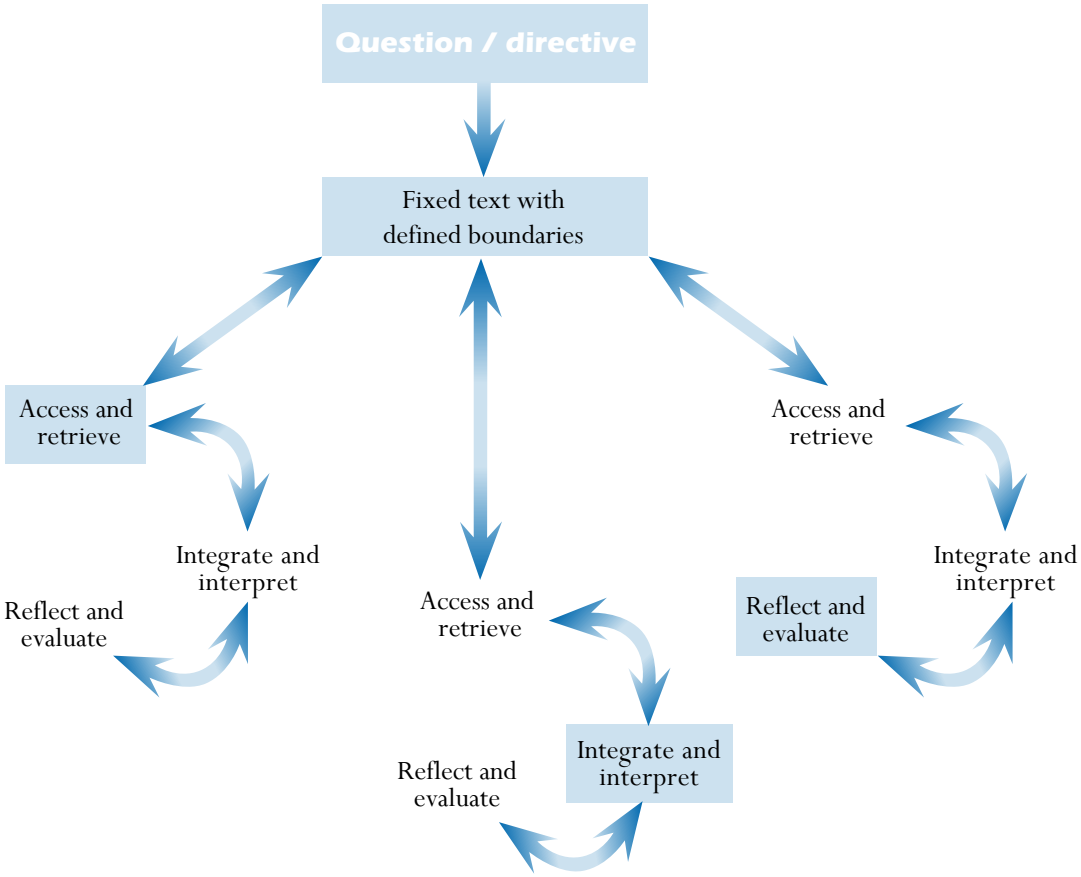
The aspects of reading in print and electronic media

The three broad aspects defined for PISA reading literacy are not conceived of as entirely separate and independent, but rather as interrelated and interdependent. Indeed from a cognitive processing perspective they can be considered semi-hierarchical: it is not possible to interpret or integrate information without having first retrieved it, and it is not possible to reflect on or evaluate information without having made some sort of interpretation. In PISA, however, the focus is on developing an *assessment* framework that will guide the construction of an assessment to operationalise and subsequently measure proficiency in different aspects of the reading domain. The framework description of reading aspects distinguishes approaches to reading that are demanded for different contexts and purposes; these are then reflected in assessment tasks that emphasise one or other aspect. All readers, irrespective of their overall proficiency, are expected to be able to demonstrate some level of competency in each of the reading aspects (Langer, 1995), since all are seen as being in the repertoire of each reader at every developmental level.

Given that the aspects are rarely if ever entirely separable, the assignment of a task to an aspect is often a matter of fine discrimination that involves judgements about the salient (most important) features of the task, and about the predicted typical approach to it. Figure 1.4 and Figure 1.5 represent the way the aspects are operationalised in different tasks, in print and electronic media respectively. The boxes around aspect names represent the emphasis of the task, while the presence of the other aspects at each task point acknowledge that all the aspects (as cognitive processes) are likely to play some role in each task.

For the most part, identifying the aspect for each PISA reading literacy task – the task being the question or directive that the student sees – will depend on the objective of the task. For example, retrieving a single piece of explicitly stated information from a web page (such as finding out the number of Internet users worldwide) may involve a complex series of steps requiring the evaluation of the relevance of several results on a search result page, comparing and contrasting descriptions and deciding which of several sources is likely to be most authoritative. Nevertheless, if the ultimate task, finding the number of Internet users worldwide, is stated explicitly once the target page has been reached, this task is classified as *access and retrieve*. This is the approach that has been taken in PISA print reading to classify each task by aspect.

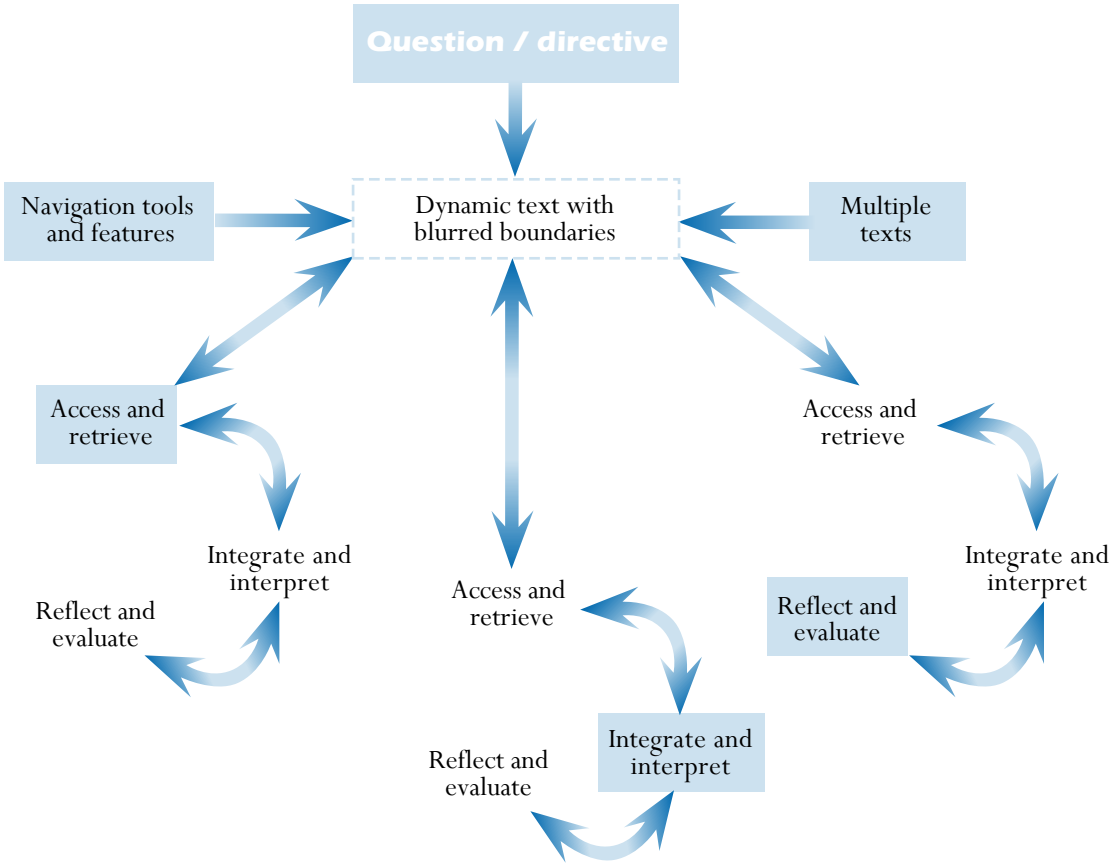
Figure 1.4 ■ **Relationship between task, text and aspects in the print medium**



Complex electronic reading tasks – simulating the complexity of real-life reading

In both the print and electronic media, real-life reading tasks can typically involve searching for information in what is essentially an unlimited space. In the print world, we might go to a library, search a catalogue, browse on the library shelf, and then, having found what looks like the right book or books, scan the contents and flip through pages before making a selection of one or many resources. In the electronic medium, the parallel process is experienced sitting at a computer screen and accessing a database or the Internet. This is a much more contained task in geographical space and time, but the processes of sorting, selecting, evaluating and integrating are in many respects similar to searching for information in the print medium. Practical constraints have meant that reading assessments like PISA cannot measure students' proficiency in searching for print resources. Consequently, the large-scale assessment of reading has generally confined itself, until now, to tasks that involve reading rather short and clearly designated texts. By contrast, large scale assessments can, in the electronic medium, authentically measure proficiency in accessing, selecting and retrieving information from a wide range of possible resources. Therefore, insofar as the cognitive processing in the two media is parallel, an assessment of electronic reading makes it possible to measure something that has until now, not been measurable in a large-scale assessment.

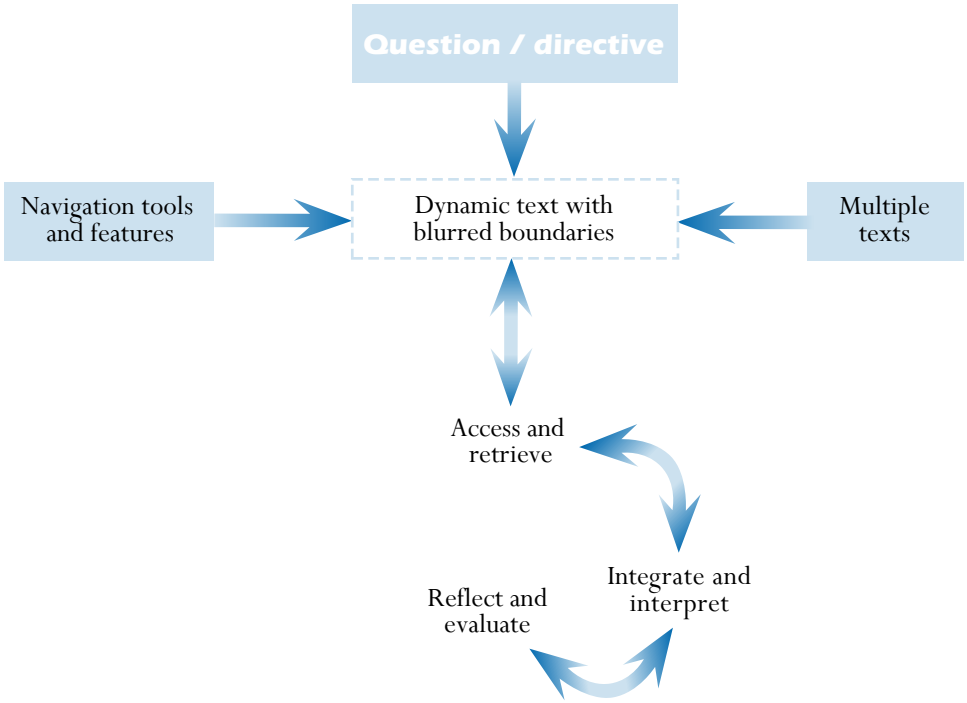
Figure 1.5 ■ **Relationship between task, text and aspects in the electronic medium**



One important point made about the difference between print and electronic reading is the lack of obvious direction provided to the reader in the electronic medium. In the print medium the arrangement and organisation of (a single) text is given to the reader by the author's ordering of pages, chapters or larger sections. The reader may choose to take a different path, but a path is nevertheless suggested by the physical arrangement of the text. In hypertext on the other hand the reader has no direction – or, to put it more positively, the reader has far greater control of the selection and sequence of reading. In effect, control is forced upon the reader.

In order to simulate the real-life freedom (or forced independence) of reading in the electronic medium, some part of electronic reading assessment is designed in the form of *complex reading tasks*. Here not only is the range of texts comparatively undefined, but also the optimal sequence of steps to be taken in completing the task is not pre-determined. These are tasks which take advantage of the compression and economy of electronic reading resources. They also require the use of the variety of skills: accessing and retrieving; interpreting and integrating; and reflecting and evaluating. The task cannot therefore be assigned to a single aspect. The equal status of the three aspects, and their relationship to dynamic reading texts, is represented in Figure 1.6.

Figure 1.6 ■ **Relationship between task, text and aspects in complex reading tasks**



While the three aspects do not usually operate entirely independently of one another in either print or electronic reading tasks, it is possible to construct relatively simple tasks in which there is a clear emphasis on one or the other aspect. In complex tasks, on the other hand, the process is not so well defined. The reader assimilates the task, and then confronts the problem of interpreting, extrapolating from and evaluating the immediately visible text (for example, the home page of a website) to find relevant information. In order to do this an experienced reader in the electronic medium uses knowledge about access structures and typical site structures (just as an experienced print reader uses knowledge about generic textual structures and features). It is not just a matter of knowledge however: a skilled reader of electronic texts also needs to theorise and construct logical and interpretive connections between seen and unseen multiple texts. In an authentic, complex task in the electronic medium, the reader needs to process the visible information immediately and extrapolate from it: making judgments, synthesising and accessing information in an integrated, recursive sequence.

In order to maintain trend and represent the balance of the aspects applicable in the assessment environment, the distribution by aspect across the print-based assessment remains similar to that of PISA 2000. In the electronic reading assessment, however, the tasks are spread more equally across the three traditional aspects and the new composite aspect, *complex*. The approximate distribution of tasks by aspect in print and electronic media is shown in Table 1.4.

Table 1.4 **Approximate distribution of tasks by aspect for PISA 2009**

Aspect	% of total tasks PISA 2009: print	% of total tasks PISA 2009: electronic
Access and retrieve	25	25
Integrate and interpret	50	35
Reflect and evaluate	25	20
Complex	0	20
TOTAL	100	100

Summary of the relationship between printed and electronic reading texts and tasks

Table 1.5 presents some of the esessential similarities and differences between print and electronic reading. One purpose of the table is to describe intrinsic similarities and differences between print reading and electronic reading. In many cases the entries under Print reading and Electronic reading are identical. In other places, the descriptions highlight some essential differences between reading in the two media.

A second purpose of the table is to illustrate similarities and differences in what PISA *assesses* in the two media. In some cases it is a matter of prominence and emphasis: square brackets signify that a feature is given relatively little emphasis in the PISA assessment. In other cases the difference is more absolute. While some features exist in both media, they cannot be or are not assessed in PISA. These are represented in grey scale. One of the principles in constructing the PISA frameworks and the assessment tasks that operationalise them is to represent the domains authentically. There is no set way of doing this, and in a sense the decisions and selections made are arbitrary – though based on the best judgment of international reading experts. How the domain is described and operationalised, in this and other respects, is determined by a combination of conceptual, empirical and political considerations. The aim in the scoping of the domain outlined above is to explain the basis for building an assessment for PISA 2009 that captures the essence of reading literacy. Such an assessment will in turn yield an array of data from which to report 15-year-olds' reading proficiency in ways that are comprehensive, meaningful and relevant.

Table 1. 5 Similarities and differences between print and electronic reading, by main framework characteristics

	Print reading	Electronic reading
Situations	Personal Public Occupational Educational	Personal Public Occupational Educational
Texts: Environments	not applicable	Authored Message based
Texts: Formats	Continuous Non-continuous [Mixed] [Multiple]	[Continuous] [Non-continuous] [Mixed] Multiple
Texts: Text type	Argumentation Description Exposition Narration Instruction Transaction	Argumentation Description Exposition Narration Instruction Transaction
Aspects (1)	Access and retrieve Search Orient and navigate in concrete information space e.g. *Go to library, search in a catalogue, find a book* Use navigation tools and structures e.g. *Table of contents; page numbers; glossary* Select and sequence information - low reader control - one sequence of linear reading	Access and retrieve Search Orient and navigate in abstract information space e.g. *Enter URL; user search engines* Use navigation tools and structures e.g. *Menus; embedded hyperlinks* Select and sequence information - high reader control - multiple sequences of linear reading
Aspects (2)	Integrate and interpret Integrate at a lower level of demand: larger portions of text are simultaneously visible (one or two pages) Develop an interpretation Form a broad understanding	Integrate and interpret Integrate at a higher level of demand: limited parts of text are simultaneously visible (limited by screen size) Develop an interpretation Form a broad understanding
Aspects (3)	Reflect and evaluate Pre-evaluate information e.g. *use table of contents; skim passages, checking for credibility and usefulness* [Evaluate credibility of source *- usually less important due to filtering and preselection in the publishing process*] Evaluate plausibility of content Evaluate coherence and consistency Hypothesise Reflect in relation to personal experience	Reflect and evaluate Pre-evaluate information e.g. *use menus; skim web pages, checking for credibility and usefulness* Evaluate credibility of source *- usually more important due to lack of filtering and preselection in open environment* Evaluate plausibility of content Evaluate coherence and consistency Hypothesise Reflect in relation to personal experience
Aspects (4)	Complex The range of sources to be consulted is relatively undefined The sequence of steps within the task is undirected e.g. *finding, evaluating and integrating information from multiple printed texts*	Complex The range of sources to be consulted is relatively undefined The sequence of steps within the task is undirected e.g. *finding, evaluating and integrating information from multiple electronic texts*

ASSESSING READING LITERACY

The previous section outlined the conceptual framework for reading literacy. The concepts in the framework must in turn be represented in tasks and questions in order to collect evidence of students' proficiency in reading literacy.

Building tasks in the print medium

The distribution of tasks across the major framework variables of situation, text and aspect was discussed in the previous section. In this section some of the other major issues in constructing and operationalising the assessment are considered: factors affecting item difficulty, and how difficulty can be manipulated; the choice of response formats; and some issues around coding and scoring.

Factors affecting item difficulty

The purpose of the PISA reading literacy assessment is to monitor and report on the reading proficiency of 15-year-olds as they approach the end of compulsory education. Each task in the assessment is designed to gather a specific piece of evidence about that proficiency by simulating a reading activity that a reader might carry out either inside or outside school, as an adolescent or as an adult.

The PISA reading literacy tasks range from very straightforward comprehension activities to quite sophisticated activities requiring deep and multiple levels of understanding. The difficulty of any reading literacy task depends on an interaction amongst several variables. Drawing on Kirsch and Mosenthal's work (see for example Kirsch, 2001; Kirsch & Mosenthal, 1990), we can manipulate the difficulty of items by applying knowledge of the following aspect and text format variables.

In *access and retrieve* tasks, difficulty is conditioned by the number of pieces of information that the reader needs to locate, by the amount of inferencing required, by the amount and prominence of competing information, and by the length and complexity of the text.

In *integrate and interpret* tasks, difficulty is affected by the type of interpretation required (for example, making a comparison is easier than finding a contrast); by the number of pieces of information to be considered; by the degree and prominence of competing information in the text; and by the nature of the text: the less familiar and the more abstract the content and the longer and more complex the text, the more difficult the task is likely to be.

In *reflect and evaluate* tasks, difficulty is affected by the type of reflection or evaluation required (from least to most difficult, the types of reflection are: connecting; explaining and comparing; hypothesising and evaluating); by the nature of the knowledge that the reader needs to bring to the text (a task is more difficult if the reader needs to draw on narrow, specialised knowledge rather than broad and common knowledge); by the relative abstraction and length of the text; and by the depth of understanding of the text required to complete the task.

In tasks relating to *continuous texts*, difficulty is influenced by the length of the text; the explicitness and transparency of its structure; how clearly the parts are related to the general theme; and whether there are text features such as paragraphs or headings, and discourse markers such as sequencing words.

In tasks relating to *non-continuous texts*, difficulty is influenced by the amount of information in the text; the list structure (simple lists are easier to negotiate than more complex lists); whether the components are ordered and explicitly organised, for example with labels or special formatting; and whether the information required is in the body of the text or in a separate part, such as a footnote.

Response formats

The form in which the evidence is collected – the *response format* – varies according to what is considered appropriate given the kind of evidence that is being collected, and also according to the pragmatic constraints of a large-scale assessment. As in any large-scale assessments the range of feasible item formats is limited, with multiple-choice and short constructed-response items (where students write their own answer) being the most manageable formats.

Several studies based on PISA data suggest that response format has a significant effect on the performance of different groups: for example, students at different levels of proficiency (Routitsky & Turner, 2003); students in different countries (Grisay & Monseur, 2007); and boys and girls (Lafontaine & Monseur, 2006). Given this variation, Lafontaine and Monseur caution that in measuring trends over time, it is important to maintain a similar proportion of tasks in multiple choice and constructed response formats from one administration to the next. A further significant consideration in the context of reading literacy is that open constructed response items are particularly important for the reflection and evaluation aspect, where the intent is often to assess the quality of thinking rather than the conclusion itself. Finally, students in different countries are more or less familiar with various response formats. Including items in a variety of formats is likely to provide some balance between more and less familiar formats for all students, regardless of nationality.

In summary, to ensure proper coverage of the ability ranges in different countries, to ensure fairness given the inter-country and gender differences observed, and to ensure a valid assessment of the reflect and evaluate aspect, both multiple choice and open constructed response items continue to be used in PISA reading literacy assessments. Any major change in the distribution of item types in print reading might also impact on the measurement of trends. In the interests of economy, however, and to take advantage of the capacity for automated coding that the electronic medium offers, for the electronic reading assessment a higher proportion of items requiring no coder judgement has been included.

Table 1.6 and Table 1.7 show coding requirements for print and electronic tasks respectively. The distribution is shown in relation to the three aspects of reading literacy for print literacy and the four aspects described for the electronic reading assessment. Items that require expert judgement consist of open constructed and short constructed responses. Items that do not require coder judgement consist of multiple choice, complex multiple choice and closed constructed response items. The closed constructed response items are those that require the student to generate a response, but require minimal judgment on the part of a coder. For example, a task in which a student is asked to copy a single word from the text, where only one word is acceptable, would be classified as a closed constructed response item. Such items impose a minor cost burden in operational terms and therefore from a pragmatic perspective, these closed constructed response items can be grouped with multiple choice items.

Table 1.6 **Approximate distribution of tasks by coding requirement for PISA 2009: print medium**

Aspect	% of tasks requiring expert judgment in coding	% of tasks not requiring expert judgment in coding	% of test
Access and retrieve	11	14	25
Integrate and interpret	14	36	50
Reflect and evaluate	18	7	25
TOTAL	43	57	100

Table 1.7 **Approximate distribution of tasks by coding requirement for PISA 2009: electronic medium**

Aspect	% of tasks requiring expert judgment in coding	% of tasks not requiring expert judgment in coding	% of test
Access and retrieve	0	25	25
Integrate and interpret	0	35	35
Reflect and evaluate	15	5	20
Complex	15	5	20
TOTAL	30	70	100

The tables indicate that while there is some distribution of items that require coder judgement and those that do not across the aspects, they are not distributed evenly. The reflection and evaluation aspect in both media and the complex tasks in the electronic reading assessment are assessed through a larger percentage of constructed response items, which require expert coder judgment.

Coding and scoring

Codes are applied to test items, either by a more or less automated process of capturing the alternative chosen by the student for a multiple choice answer, or by a human judge (expert coder) selecting a code that best captures the kind of response given by a student to an item that requires a constructed response. The code, of either type, is then converted to a score for the item. Scoring is relatively simple with multiple-choice items or other closed response format items such as selecting an item from a drop down menu in the electronic medium: the student has either chosen the designated correct answer or not, so the item is scored as 1 or 0 respectively.

Partial-credit models allow for more complex scoring of constructed response items. Some answers, even though incomplete, are better than others. Given that incomplete answers indicate a higher level of reading literacy than inaccurate or incorrect answers, they receive partial credit. Such items are then scored polytomously – that is, there is a full credit score, one or more partial credit scores, and a no credit score. Psychometric models for such polytomous scoring are well established and in some ways are preferable to dichotomous scoring (full credit or no credit), as they use more of the information in the responses. Interpretation of polytomous scoring is more complex, however, as each task will have several locations on the difficulty scale: one for the full-credit answer and others for each of the partial-credit answers. Partial-credit scoring is used for some of the more complex constructed response items in PISA.

There is a great range of constructed response tasks. Some require little judgement on the coder's part; these include tasks that ask the reader to simply mark parts of the text to indicate an answer or to list a few words. Others require considerable judgement on the part of coder, as for example when the reader is asked to explain the main idea of a text in his or her own words.

The following three examples illustrate some of the salient variables addressed in the construction of print reading items, including situation, text format, text type, and aspect. They also illustrate a range of response formats and coding and scoring features. The three items were part of the PISA reading literacy instrument administered in the field trial for PISA 2009. The first and third were also administered in the PISA main survey in the year 2000.

PRINT READING UNIT 1

MACONDO

> Dazzled by so many and such marvellous inventions, the people of Macondo did not know where their amazement began. They stayed up all night looking at the pale electric bulbs fed by the plant that Aureliano Triste had brought back when the train made its second trip, and it took time and effort for them to grow accustomed to its obsessive toom-toom. They became indignant over the living images that the prosperous merchant Don Bruno Crespi projected in the theatre with the lion-head ticket windows, for a character who had died and was buried in one film, and for whose misfortune tears of affliction had been shed, would reappear alive and transformed into an Arab in the next one. The audience, who paid two centavos apiece to share the difficulties of the actors, would not tolerate that outlandish fraud and they broke up the seats. The mayor, at the urging of Don Bruno Crespi, explained by means of a proclamation that the cinema was a machine of illusions that did not merit the emotional outburst of the audience. With that discouraging explanation many felt that they had been the victims of some new and showy gypsy business and they decided not to return to the movies, considering that they already had too many troubles of their own to weep over the acted-out misfortunes of imaginary beings.

Macondo is a piece of prose from the novel *One Hundred Years of Solitude* by the Colombian author Gabriel Garcia Márquez. It is classified as belonging to the personal situation because it was written for readers' interest and pleasure. The Macondo unit in PISA is introduced with a brief paragraph to orientate the reader: "The passage on the opposite page is from a novel. In this part of the story, the railway and electricity have just been introduced to the fictional town of Macondo, and the first cinema has opened." The people's reaction to the cinema is the focus of the passage. While the historical and geographical setting of the extract is exotic for most readers, going to the movies is within the experience of 15-year-olds, and the characters' responses are at the same time intriguing and humanly familiar. Within the *continuous* text format category, *Macondo* is an example of narrative writing in that it shows, in a manner typical of this text type, why characters in stories behave as they do, recording actions and events from the point of view of subjective impressions.

The Macondo unit comprises tasks covering the aspects of *integrate and interpret* and *reflect and evaluate*. One of the tasks is reproduced below. Further tasks can be found in Annex A1. The numbering of the tasks is identical to the numbering used in the test booklets given to students.

Question 3: MACONDO

At the end of the passage, why did the people of Macondo decide not to return to the movies?

A. They wanted amusement and distraction, but found that the movies were realistic and depressing.

B. They could not afford the ticket prices.

C. They wanted to save their emotions for real-life occasions.

D. They were seeking emotional involvement, but found the movies boring, unconvincing and of poor quality.

The correct answer is C.

This task requires integrating and interpreting to form a broad understanding. In order to gain credit, students need to synthesise elements across the text to identify the reason that the characters in the story behaved as they did at the end. In selecting option C, they must reject some reasons that could plausibly explain why people might decide not to go to the movies, represented by distractors that are based on preconceptions rather than on the text.

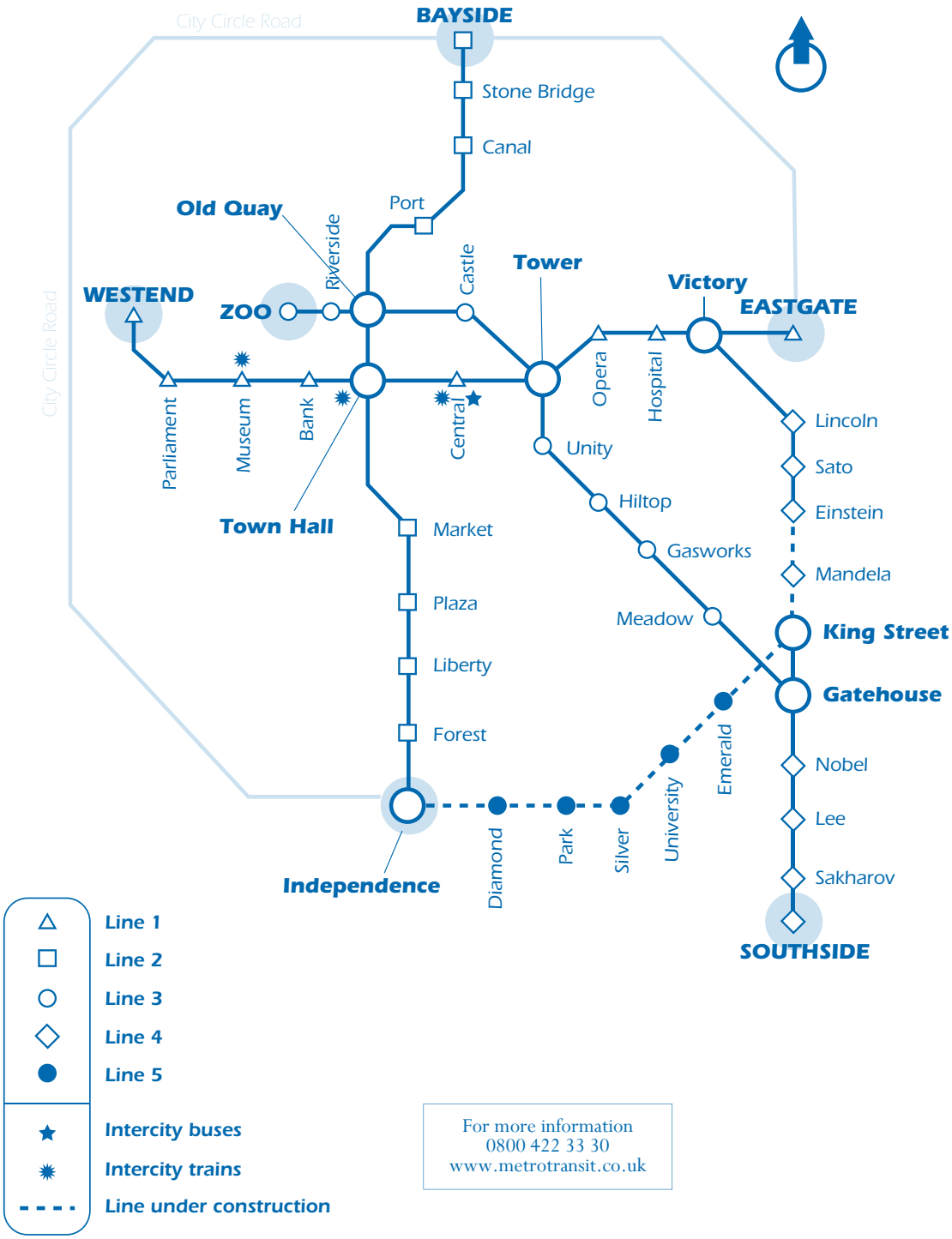
Table 1.8 summarises the framework characteristics of the *Macondo* question.

Table 1.8 **Framework characteristics of sample task: Macondo**

Situation	Personal
Text format	Continuous
Text type	Narration
Aspect	Integrate and interpret: Form a broad understanding
Item format	Multiple choice

PRINT READING UNIT 2

METROTRANSIT



The Metrotransit unit from the PISA 2009 field trial presents a graphic from a public document, a map of an urban transport network in the form of a diagram. It uses fictional place names that participating countries were invited to adapt for their national versions. The text is non-continuous; it could be presented as a combined list of stations categorised according to line, features and grid locations. Though relatively simple, it includes a complicating element – a key of symbols – the application of which is required to gain full credit for the question reproduced below.

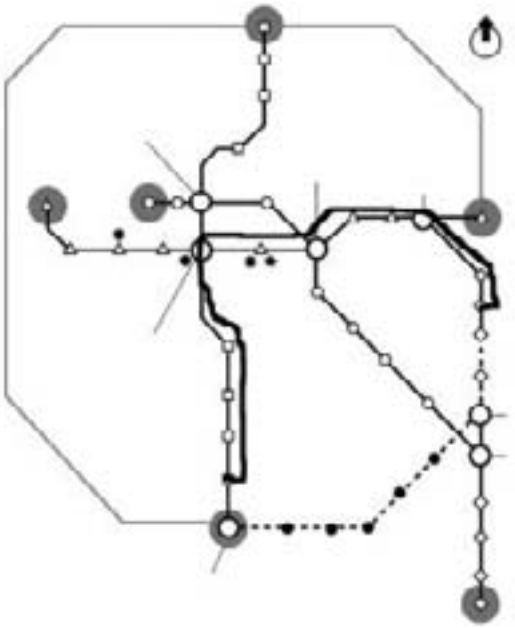
Question 4: METROTRANSIT

You need to find the shortest route by underground rail from Sato Station to Forest Station.

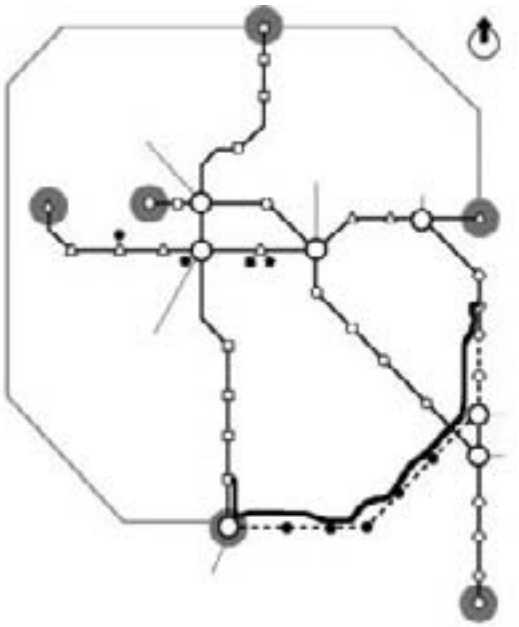
Draw on the map the route that you would take.

This *access and retrieve* task requires students to locate and sequence multiple pieces of information – the names of stations – to plan a route. The task simulates a real-life experience that demands careful reading of a non-continuous text. The item was constructed to ensure that use of conditional information – that is, information external to the main part of a text – must be processed in order to complete the task successfully. For full credit, students therefore need to use the information provided in the key: that part of the system that is under construction. Students who take account of this conditional information realise that what is apparently the shortest route is currently unusable. The requirement to use conditional information increases the difficulty of items significantly. Only about one-third of students in the field trial gained full credit for this item. However more than half of the other students, who plotted a route using stations on Line 5, were given partial credit, as they demonstrated that in all but one respect (albeit a crucial one, in practical terms) they had understood and could use information that they had retrieved. Examples of full and partial credit responses are shown below.

Full credit response



Partial credit response



Most of the items in PISA print reading require a multiple choice or text response. The short response format of this question, involving the drawing of a route on a map, illustrates that the range of response types can nevertheless vary to some extent, according to the format that seems most appropriate for the particular task. This is bounded, of course, by the practical limitations of a large-scale paper and pen test.

Table 1.9 summarises the framework characteristics of the *Metrotransit* question.

Table 1.9 **Framework characteristics of sample task: Metrotransit**

Situation	Public
Text format	Non-continuous
Text type	Description
Aspect	Access and retrieve: Retrieve information
Item format	Short response

PRINT READING UNIT 3

STUDENT OPINIONS

There are so many people out there dying from hunger and disease, yet we are more concerned about future advancements. We are leaving these people behind as we attempt to forget and move on. Billions of dollars are poured into space research by large companies each year. If the money spent on space exploration was used to benefit the needy and not the greedy, the suffering of millions of people could be alleviated.

Ana

The challenge of exploring space is a source of inspiration for many people. For thousands of years we have been dreaming of the heavens, longing to reach out and touch the stars, longing to communicate with something we only imagine could exist, longing to know... Are we alone?

Space exploration is a metaphor for learning, and learning is what drives our world. While realists continue to remind us of our current problems, dreamers stretch our minds. It is the dreamers' visions, hopes and desires that will lead us into the future.

Beatrice

We ruin rain forests because there is oil under them, put mines in sacred ground for the sake of uranium. Would we also ruin another planet for the sake of an answer to problems of our own making? Of course!

Space exploration strengthens the dangerous belief that human problems can be solved by our ever-increasing domination of the environment. Human beings will continue to feel at liberty to abuse natural resources like rivers and rain forests if we know there is always another planet around the corner waiting to be exploited.

We have done enough damage on Earth. We should leave outer space alone.

Dieter

The earth's resources are quickly dying out. The earth's population is increasing at a dramatic rate. Life cannot be sustained if we continue to live in such a way. Pollution has caused a hole in the ozone layer. Fertile lands are running out and soon our food resources will diminish. Already there are cases of famine and disease caused by over-population.

Space is a vast empty region which we can use to our benefit. By supporting exploration into space, one day we may find a planet that we can live on. At the moment this seems unimaginable, but the notion of space travel was once thought of as impossible. Discontinuing space exploration in favour of solving immediate problems is a very narrow-minded and short-term view. We must learn to think not only for this generation but for the generations to come.

Felix

To ignore what the exploration of space has to offer would be a great loss to all mankind. The possibilities of gaining a greater understanding of the universe and its beginnings are too valuable to waste. The study of other celestial bodies has already increased our understanding of our environmental problems and the possible direction Earth could be heading in if we don't learn to manage our activities.

There are also indirect benefits of research into space travel. The creation of laser technology and other medical treatments can be attributed to space research. Substances such as teflon have come out of mankind's quest to travel into space. Thus new technologies created for space research can have immediate benefits for everyone.

Kate

The stimulus for the unit *Student Opinions* consists of five short argumentative texts that offer opinions about space research. Because it is based on writing by students in their final year of school, the text is classified as *educational* in terms of situation. All of the short pieces that make up the stimulus for this unit are continuous, but they were generated independently, and are juxtaposed for the purposes of the assessment, the format category is *multiple* texts. The stimulus is classified as *argumentation*, as the texts set forth propositions and attempt to persuade the reader to a point of view.

Several of the tasks that were based on this stimulus were *integrate and interpret* questions that represent typical active reading, as they simulate the processes that readers might engage in as they compare and contrast the opinions of different authors on a topic. Another typical active reading approach in encountering one or more written arguments is to compare one's own position with those of the writers. The sample task that follows represents that kind of reflective and evaluative reading activity. Further tasks can be found in Annex A1. The numbering of the tasks is identical to the numbering used in the test booklets given to students.

Question 6: STUDENT OPINIONS

Thinking about the main ideas presented by the five students, which student do you agree with most strongly?

Student's name: .....

Using your own words, explain your choice by referring to your own opinion **and** the main ideas presented by the student.

.....

.....

.....

.....

This task requires students to draw on their own knowledge and beliefs to evaluate the arguments put forward by the writers, comparing the substance rather than the form of the texts. In the five-aspect categorisation, this task is therefore classified as *reflecting on the content of a text*. In order to gain credit for this item, students needed to demonstrate implicitly or explicitly that they understood the main thrust of the argument advanced by their chosen writer, as well as justifying their position, either by introducing their own supporting argument or by summarising or interpreting the argument given by the writer.

Full credit was available regardless of which writer was nominated by the student, as long as the criteria outlined above were satisfied. Some typical answers that earned full credit were:

- *Ana – I feel that we should take care of what is going on in our own world before we blow all our money on space exploration. I understand the importance of some exploration but I think disease and famine need to be helped out of this world first.*

- *Dieter – I agree with him because he is concerned with the environment and he thinks that we should leave outer space alone.*
- *Felix – I agree with Felix because unless we are willing to face extinction, there is no other place to go after we have wrecked the earth.*

Answers that were not given credit often quoted from one of the texts without addition, whereas the task directed students to use their own words. Other responses that gained no credit were vague, or offered a general opinion without substantiating it with reference to one of the texts (for example, "Dieter. Let's look at the realities.).

Table 1.10 summarises the framework characteristics of the *Student Opinions* question.

Table 1.10 **Framework characteristics of sample task: Student Opinions**

Situation	Educational
Text format	Multiple
Text type	Argumentation
Aspect	Reflect and evaluate: Reflect on and evaluate the content of a text
Item format	Open constructed response

Extending the descriptive power of the PISA scales by manipulating item difficulty

In PISA 2000, PISA 2003 and PISA 2006 it has been noted that, while the level of proficiency of students can be located accurately, there is a shortage of descriptive information about what students at the extremes – particularly at the lower end of the distribution – know and can do as readers. This is because there are few existing PISA tasks at the very easy end and the difficult end, where the proficiency level of significant numbers of students in all participating countries is located. In developing tasks for PISA 2009, therefore, there was an emphasis on including some very easy and some very difficult items. In addition to enhancing the descriptive power of the scale, better matching of the item difficulties to the student achievement distributions in each country may improve the reliability of the population parameter estimates. Moreover, the test experience for individual students, particularly those performing at very low levels, will become more satisfying.

Developing items for the lower levels of proficiency was achieved by manipulating elements from PISA's descriptive framework as follows:

- using shorter and simpler texts
- ensuring closer literal match of terms between the item and the text
- providing more direction about the location in the text of the information relevant for solving the item
- addressing personal and familiar experiences in reflecting on and evaluating content items, rather than remote, abstract issues
- addressing concrete features in reflecting on and evaluating form items

The following two examples illustrate tasks designed explicitly to address the extremes of the difficulty continuum in PISA reading. The first is a very easy item, the second a very difficult one. These two items were administered in the PISA 2009 field trial.

PRINT READING UNIT 4

SUPERMARKET NOTICE

Peanut Allergy Alert
Lemon Cream Biscuits

Date of alert: 04 February
Manufacturer's Name: Fine Foods Ltd
Product Information: 125g Lemon Cream Biscuits (Best before 18 June and Best before 01 July)
Details: Some biscuits in these batches may contain pieces of peanut, which are not included in the ingredient list. People with an allergy to peanuts should not eat these biscuits.
Consumer action: If you have bought these biscuits you may return the product to the place of purchase for a full refund.
Or call 1800 034 241 for further information.

This public notice consists of a very short text that has an everyday function: to warn about the possible danger of a product to consumers and to give advice to return the product for a refund. While the formatting of the stimulus reflects the international standard for product recall notices, many students may not have seen this kind of notice. Nevertheless, the content of the warning is clearly set out and a minimum number of words is used. Lemon biscuits were chosen as the product because of their familiarity and likely appeal. As mentioned above, in developing very easy items, short simple pieces of stimulus with familiar content were sought. This was not only to make the cognitive load of the items lighter, but also to present texts that were unlikely to intimidate students with low reading proficiency, since such readers can easily be discouraged from even attempting to read something that they believe looks too hard or too long. The text format classification of the supermarket notice is non-continuous, as it consists of a list of described features. In terms of text type, the notice is instructional: it provides directions on what to do if you have bought the product.

Of the five questions addressing this stimulus that were administered in the field trial, four were successfully completed by more than 80% of students. The one reproduced below was the easiest of all, with well over 90% of students gaining full credit. Further questions can be found in Annex A1. The numbering of the questions is identical to the numbering used in the test booklets given to students.

Question 3: SUPERMARKET NOTICE

What is the name of the company that made the biscuits?

.....

To answer this question successfully the student needs to locate a single explicitly stated piece of information in the text, using a synonymous match between the task direction and the text (company/manufacturer). The fact that the whole text is very short, and that the needed information is near the beginning of the text, adds to the easiness of the task. The response format for the task is described as a closed constructed response, since only one answer (with a small range of variants: Fine Foods or Fine Foods Ltd.) is given full credit.

Table 1.11 summarises the framework characteristics of the *Supermarket Notice* question.

Table 1.11 **Framework characteristics of sample task: Supermarket Notice**

Situation	Public
Text format	Non-continuous
Text type	Instruction
Aspect	Access and retrieve: Retrieve information
Item format	Closed constructed response

Example 5, the last of the examples of reading items included in this section, was designed to help elaborate the description of student proficiency at the top end of the scale.

PRINT READING UNIT 5

DEMOCRACY IN ATHENS

Part A

Thucydides was a historian and military man who lived in the fifth century BC, during the Classical Greek period. He was born in Athens. During the Peloponnesian War (431 BC to 404 BC) between Athens and Sparta he was in command of a fleet whose mission was to protect the city of Amphipolis in Thrace. He failed to reach the city in time. It fell into the hands of Brasidas, the Spartan general, which forced Thucydides into a twenty-year exile. This granted him the opportunity of collecting detailed information from the two warring factions and the possibility of doing research for his work *History of the Peloponnesian War.*

Thucydides is regarded as one of the great historians of Ancient times. He focuses on natural causes and the behaviour of each individual rather than on fate or the intervention of divinities to explain the evolution of History. In his work, facts are not presented as mere anecdotes; rather, they are explained in an attempt to find out the reasons that led the main characters to act as they did. Thucydides' emphasis on the behaviour of individuals is why he sometimes introduces fictitious speeches: these help him explain the motivations of the historical characters.

Part B

Thucydides attributes to Pericles (fifth century BC), the Athenian ruler, the following speech in honour of the soldiers who fell in the first year of the Peloponnesian War.

Our system of government does not copy the laws of neighbouring states; we are rather a pattern to others than imitators ourselves. Our system is called democracy, since its administration depends on the many instead of the few. Our laws afford equal rights to all in their private affairs, whereas the prestige in public life depends on merit rather than on social class.

Social class does not prevent a person from holding any public position either ( ). And, at the same time that we do not interfere in private affairs, we do not break the law as regards public matters. We give our obedience to those whom we put in positions of authority, and we obey the laws themselves, especially those which are for the protection of the oppressed, and those unwritten laws which it is an acknowledged shame to break.

Furthermore, we provide plenty of means for the pleasure of the mind. The games and sacrifices we celebrate all the year round, and the elegance of our private places of residence, form a daily source of pleasure that helps to banish any worry; while the many inhabitants of the city draw the produce of the world into Athens, so that to the Athenian the fruits of other countries are as familiar as those of his own.

Democracy in Athens consists of two fairly short but dense texts. The first is classified as expository, although the first paragraph if considered alone could better be described as narration, since it gives an account of when something happened, referring to a sequence of events in a person's life. However, in the context of the whole of Part A, the biographical paragraph serves as an introduction to the more substantial second paragraph, which places Thucydides in the context of ideas, describing his originality as an historian. Part A as a whole, then, provides an explanation of concepts or mental constructs, which is a marker of expository texts.

Part B presents a sample of one of the "fictitious speeches" written by Thucydides that are referred to in Part A. Part B is an argumentative text, words imagined as having been spoken by Pericles in a speech of political persuasion. Part of the challenge of reading the stimulus as a whole is understanding the relationship between the two texts: it is not stated explicitly but can be inferred from the last sentence of Part A and the introduction to Part B. Other features that make this stimulus likely to be relatively difficult for 15-year-olds are its remoteness from their everyday experience, the abstractness of the language and the formal register, particularly of the rendition of Thucydides' writing. On the other hand it is reasonable to suppose that most students at the end of their compulsory schooling are fairly familiar with history as a concept, and have some notion – even if not necessarily articulated – of what democracy might be. This assumed background was judged to provide sufficient context for students to approach the *Democracy in Athens* material.

The questions related to this stimulus that were administered in the PISA 2009 field trial reflect two of the aspects: *access and retrieve* and *integrate and interpret*. Some of the questions focus on one or other of the two Parts, and some are designed to draw on an integrated understanding of the two. The one shown here draws mostly on Part B. Further questions can be found in Annex A1. The numbering of the questions is identical to the numbering used in the test booklets given to students.

Question 3: DEMOCRACY IN ATHENS

One purpose of the speech in Part B was to honour soldiers who fell in the first year of the Peloponnesian War.

What was ANOTHER purpose of this speech?

.....

.....

This is is one of the most difficult items administered in the PISA 2009 field trial. It is coded as a partial credit item, with full credit typically gained only by the most proficient readers in the field trial sample. To gain full credit, the response needs to identify the purpose of Pericles' speech by linking it to its context, which is partly provided in the expository text as well as more directly by the speech itself and by its introduction. The full credit response therefore needs to be underpinned by a full and detailed understanding of both texts, and to use a high level of inference in an unfamiliar context, dealing with some ambiguity (about the authorship of the speech). Responses in this category refer to Pericles' political motivation, possibly by mentioning such purposes as persuading soldiers to continue the struggle; consoling the families of the dead; fostering pride in the citizens of Athens; or stressing the virtues of Athens compared to Sparta or other cities. The following are examples of full credit responses:

- *to make people proud of Athens*
- *to promote the benefits of the Athenian democracy*
- *making people think Athens is still ok, despite the fact that they are in trouble right now*
- *to reinforce positive thinking and positive attitudes*
- *to make people aggressive against Spartans*

Alternatively full credit answers could refer to the more abstract level of meaning implied in Part A: Thucydides' purpose of understanding Pericles' psychology or way of thinking for example;

- *to explain the motivation of Pericles as an historical character.*

Full-credit answers do not need to be long or elaborate; yet just over a quarter of responses in the field trial were in this category. About one-fifth of participants in the field trial were able to demonstrate a partial understanding of the text, indicating that its substantial content was about democracy but without registering the persuasive intent. Responses such as the following were assigned a partial credit:

- *to introduce democracy*
- *to explain democracy to the people*

Building tasks in the electronic medium

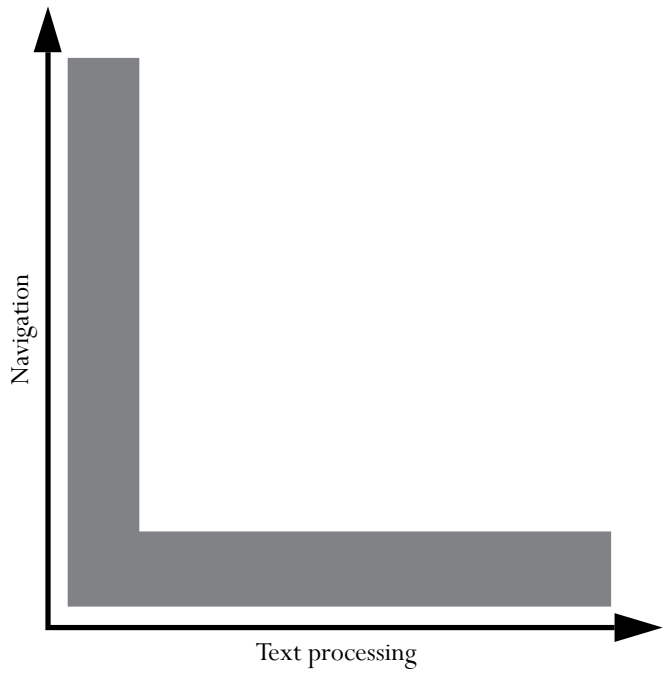
In this section some of the major issues in constructing and operationalising the electronic reading literacy assessment are considered: the relationship between navigation and text processing; analysis of tasks with a view to controlling for item difficulty; response formats; and some issues around coding and scoring. The section ends with a note on the way the students' progress through the electronic reading assessment is controlled.

Relationship between navigation and text processing in the electronic reading assessment

Reading electronic texts requires many of the same skills and understanding as reading in the print medium, but reading in each medium also requires unique skills and knowledge, particularly about the conventions that are part of the reading context. Just as knowing how to turn a page and which way up to hold a book are essential pieces of knowledge for print readers, knowledge of some techniques of navigation and some navigation features are part of being literate in the electronic medium. Such skills and knowledge should be regarded as "ICT skills" that are in conjunction with reading literacy. Both reading of text, as it is conventionally understood, and the ability to navigate within the electronic medium are conceived of as integral to proficiency in electronic reading.

All tasks in the electronic reading assessment require students to read, but individual tasks require varying proportions of text processing (for example, interpreting a paragraph of prose) and navigation. The relationship within electronic reading tasks between the mental processing devoted to navigation decisions, and that devoted to textual processing, is represented in Figure 1.7 below.

Figure 1.7 ■ **Relationship between navigation and text processing in electronic reading tasks**



Any individual task should be imagined as occupying a space somewhere within the field of the graph. The horizontal axis represents the cognitive load that is imposed by *processing the text* and the vertical axis represents the cognitive load imposed by the *navigation*. In any given reading task in the electronic medium, there will be more or less loading on the navigation and on the text processing elements. Some tasks will be very straightforward and require little of either. This kind of task would appear at the bottom left of the graph, near the origin. A second kind of task will require the reader to deal with a text that is immediately fully visible to the reader on the screen; therefore little or no navigation is required. This kind of task, with a heavy loading on text processing and light loading on navigation, would appear along the lower shaded area of the graph. A third type of task might demand one or more steps in navigation across a number of sites, with just a few

words on each page. This kind of task, requiring mainly navigation and minimal negotiation of text, would be located somewhere on the shaded area of the graph along the vertical axis. Finally, a fourth type of task, involving substantial navigation and the necessity to process a substantial piece of text (in terms of quantity and/or complexity) would be mapped in the unshaded area of the graph, indicating significant loading in terms of both navigation and text processing. The further from the origin of the graph, the more difficult the task.

As the unshaded area of Figure 1.7 indicates, most electronic reading tasks load significantly on both navigation and text processing proficiency. A relatively small number of tasks do not depend much, if at all, on navigation, but focus on straight text processing. It is considered necessary to include some tasks reflecting this type of reading in the electronic reading assessment since they represent one kind of real-life reading demand in the electronic environment. Failure to include this kind of task would artificially distance what is involved in electronic reading from print reading. Conversely, a small percentage of tasks depend mainly on navigation processing and require little, if any, text processing. Inclusion of a few such tasks, in which the reader needs to move around the electronic environment using a repertoire of knowledge and skills about the conventions of the medium and thinking about the relationships between the text objects and the navigation tools, is also seen as a valid contribution to a measure of electronic reading.

Analysis of electronic reading tasks

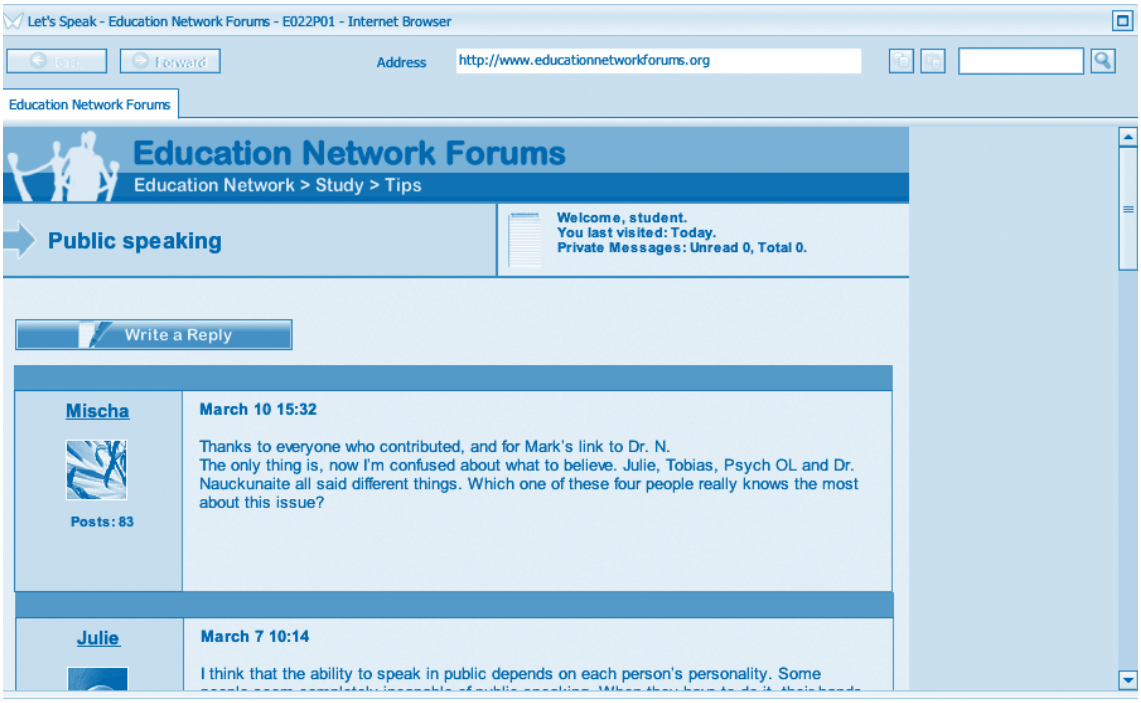
In order to capture the complexity of the steps that the reader needs to perform in the process of arriving at an explicitly called-for response, a system of analysis was used by the test developers to describe the text processing and navigation components of each task.

For any task with a moderate degree of complexity in the electronic medium, the reader is likely to have several possible ways of proceeding. For the purposes of describing and analysing subtasks, the test developers imagined an optimally efficient, but comprehensive, sequence of steps, where each step was marked by an *action*. The action could be a click on a specified link or function button; a text response in the browser area or the task area; selection from a set of alternatives in a multiple-choice format; or simply scrolling.

In the analysis, for each subtask completed with an action, the following variables were tabulated: text complexity; navigation tool/text used; aspect and description; and action. Each part of the task could therefore be described and, potentially, the difficulty of the whole task predicted. An example of an electronic reading task from the field trial showing this kind of analysis is provided below.

ELECTRONIC READING UNIT: LET'S SPEAK

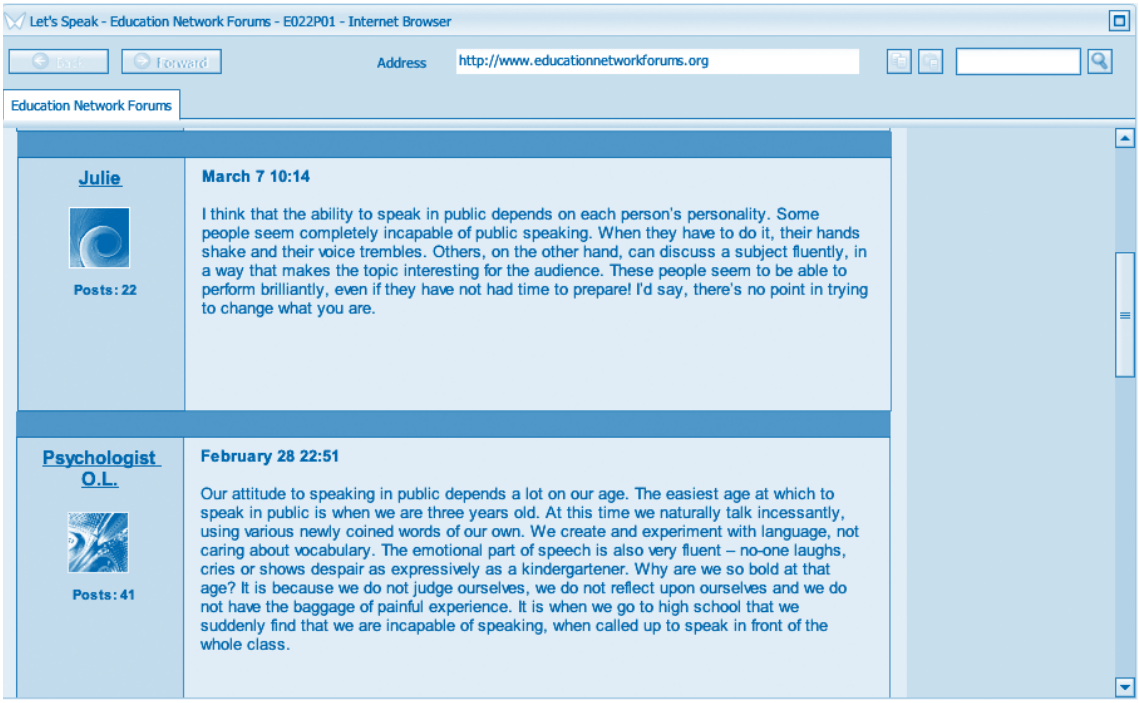
SCREEN 1A



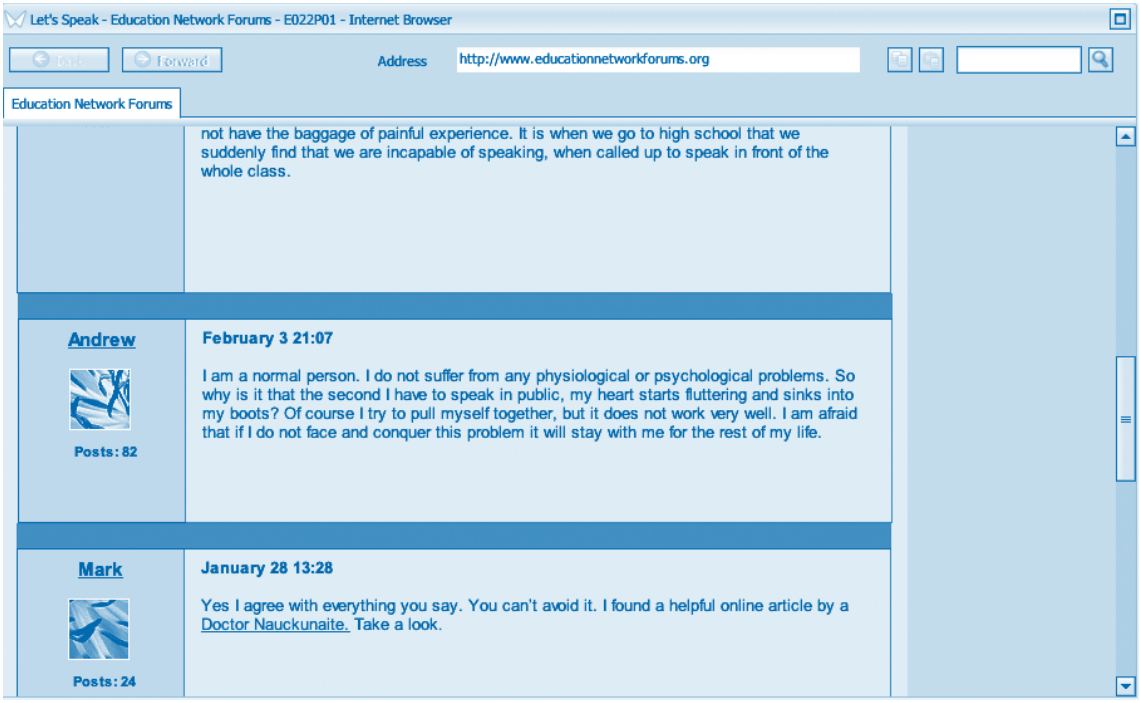
This unit was based on an online discussion forum on the subject of the challenges of speaking in public. The discussion is initiated by Mischa, whose blog entry at the bottom of the discussion forum screen (shown below in screen 1e) refers to her terror of speaking in public, to a classroom audience, and asks for help and advice. The theme of the discussion, set in an educational situation, is an example of a context that would be familiar to most of the PISA students. In terms of text format and text type, it bears some similarity to the *Student Opinions* text illustrated earlier, in that it is categorised as a multiple text, from a number of authors, and argumentative in rhetorical structure. However, unlike *Student Opinions*, *Let's Speak* presents an interactive situation in which the contributors are responding directly to each other. This is a new, or at least much accelerated kind of exchange that is an increasingly prevalent form of communication. In this kind of multiple text, understanding of each text is partly dependent on following the chain of contributions.

The discussion forum page is quite long, comprised of eight entries. In order to read the initiating entry, it is necessary to scroll down. Screens 1b to 1e show what the reader sees when scrolling down.

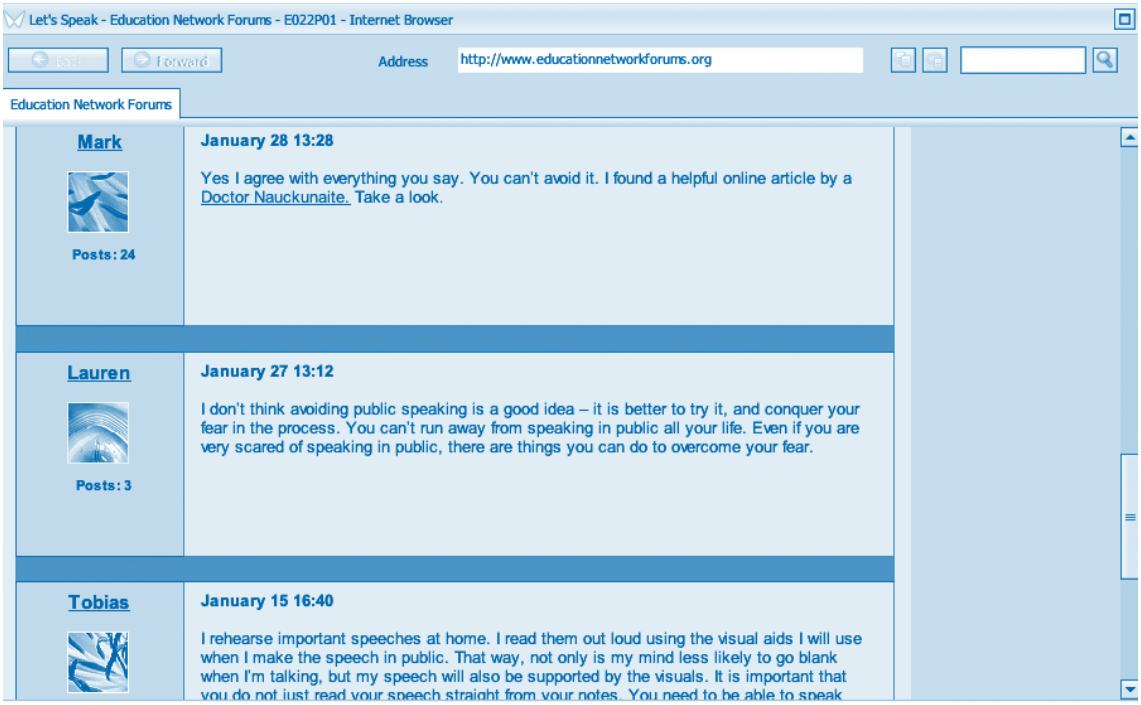
SCREEN 1B



SCREEN 1C



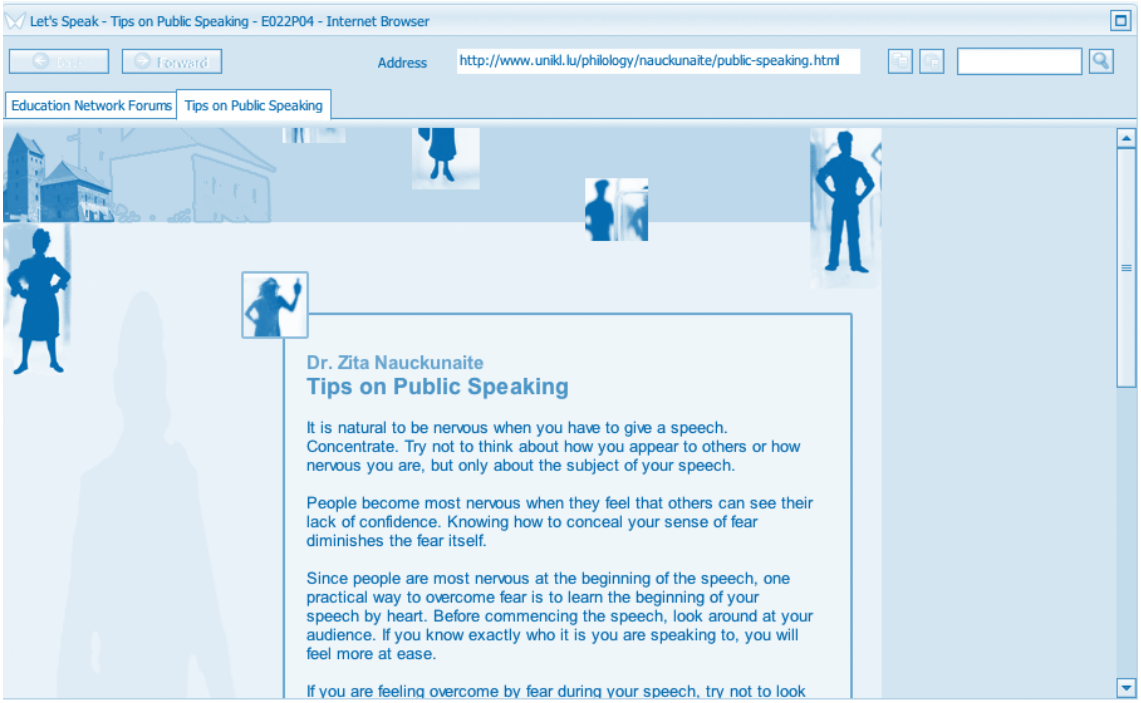
SCREEN 1D



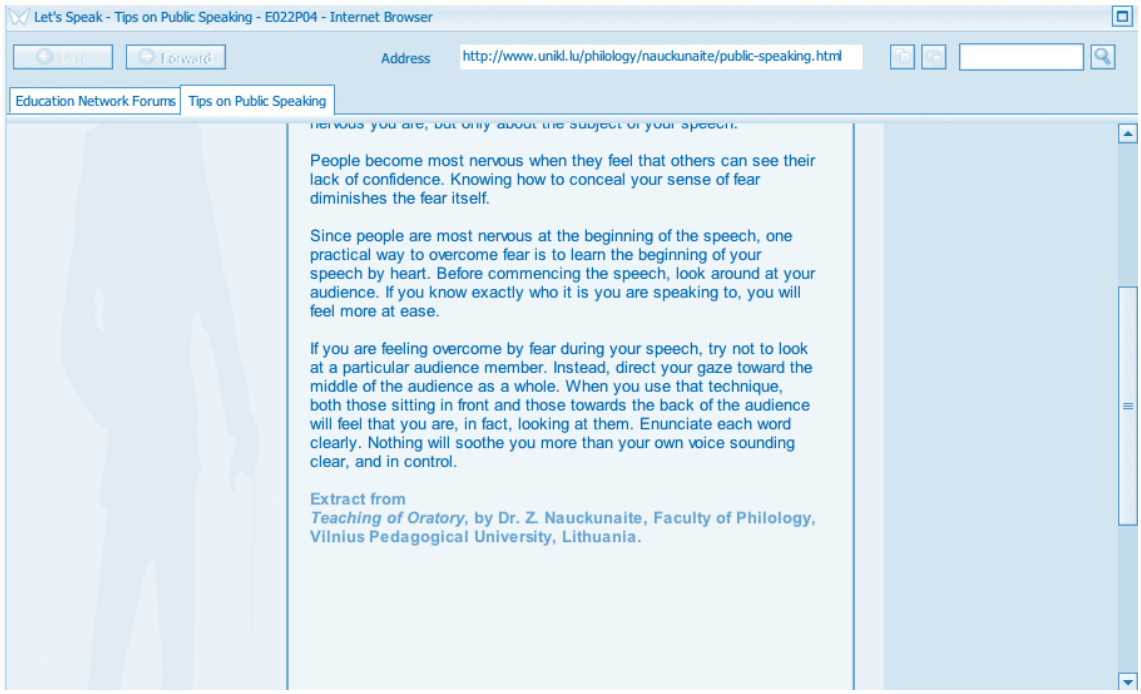
SCREEN 1E

In addition to the starting page, the unit includes only one other piece of stimulus, which is accessed by clicking on an embedded link in one of the blogs that recommends it as "expert advice". The second screen, advice from Doctor Nauckunaite, also requires some scrolling.

SCREEN 2A



SCREEN 2B



This electronic reading unit, which was administered in the field trial for PISA 2009, included several tasks that required students to understand the organisation of the website, to identify main ideas both across the blog entries and within an individual entry, and to recognise the existence of conflicting opinions. The final task directed students to read the last entry (at the top of the discussion forum page) in which Mischa has, in an imagined scenario, read all the information provided and is now requesting some final summary advice. This task is reproduced below.

Task: LETS SPEA K

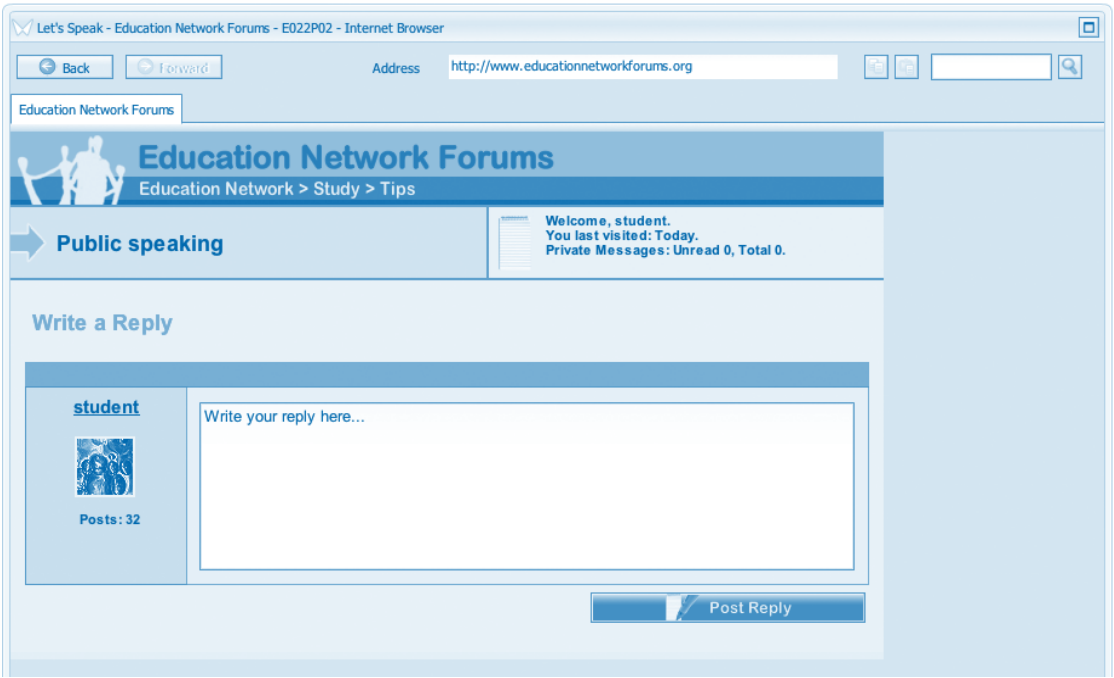
Look at Mischa's post for March 10. Click on "Write a Reply" and write a reply to Mischa. In your reply, answer her question about which writer, in your opinion, knows the most about this issue. Give a reason for your answer.

Click "Post Reply" to add your reply to the forum

This is a task that requires access and integration of several pieces of information. Mischa's second blog entry asks the reader to consider and compare four short texts (those of Julie, Tobias, Psych OL and Dr. Nauckunaite). It also requires an evaluation of the contributions, in terms of either their professional credentials, or in terms of the intrinsic quality and persuasiveness of the arguments. It is classified as a *complex* item because it draws significantly on all three aspects: *access and retrieve*, *integrate and interpret* and *reflect and evaluate*.

An added dimension of the demand of the task is that the student needs to demonstrate some proficiency in handling the formal structure and navigational conventions of the message-based environment by scrolling, clicking on a link that is embedded in the text, and finally clicking on another link (a button) to write a reply. Once the student has clicked on Write a reply , the screen below appears, with an area in which the response can be entered.

SCREEN 3



The coding of this item for the PISA 2009 field trial was based on the text response that the student enters in the Write a Reply area. (Note that full credit could be obtained for the response without clicking on Post Reply – that detail was added in the interest of authenticity.) However, in developing the item, both the text processing requirements and the navigational requirements were deliberately manipulated to shape the task for maximum contribution in populating the information space of the assessment. Table 1.12 shows a simplified version of how this *Let's Speak* task can be analysed in terms of its text processing and navigation components.

Table 1.12 Analysis of a task from electronic reading assessment, Let s Speak

Step	Start page / Required text processing / Text complexity rating	Required navigation tools / features	Aspect / text processing description	Action
1	Screen 1a One short argumentative text Rating: medium	Scrollbar	Interpret: form an understanding of the question posed in Misha's message of March 10. Access: infer that the messages of the four entries referred to in Misha's message can be accessed by scrolling, with the first blogger's name ("Julie") already visible.	Scroll down
2	Screen 1b Two short argumentative texts Rating: medium	Scrollbar	Retrieve: match on two names in Mischa's message ("Julie" and "Psychologist OL"). Interpret: form a broad understanding of the main ideas expressed in Julie's and in Psychologist OL's entries. Access: infer that entries of other required bloggers are accessible by scrolling	Scroll down
3	Screen 1c Two words highlighted in a short argumentative text Rating: low	Embedded link	Access and retrieve: locate Dr Nauckunaite's link embedded in Mark's blog.	Click on embedded link in Mark's blog
4	Screen 2a Formal text comprising expository and instructional elements Rating: medium to high	Scrollbar	Interpret: form a broad understanding of the main ideas expressed in first part of Dr Nauckunaite's page. Access: infer that article continues below bottom of screen	Scroll down
5	Screen 2b Formal text comprising expository and instructional elements Rating: medium to high	Back button	Interpret: form a broad understanding of the main ideas expressed in second part of Dr Nauckunaite's page. Access: return to discussion forum page using back button (navigation direction provided explicitly in task)	Click on Back button
6	Screens 1a to 1e Eight short argumentative texts (skim) Screen 1e One of two short argumentative texts Rating: medium	Scrollbar	Access: infer that further scrolling is required to locate the last entry named in Mischa's post. Retrieve: match on name in Mischa's message (Tobias). Interpret: form a broad understanding of the main idea expressed in Tobias's entry.	Scroll down
7	Screen 1e Write a Reply button Rating: very low	Write a Reply button	Access: access page to write a reply to Mischa	Click on Write a Reply
8	Screen 3 Text box with Write a Reply button [recall of 3 short argumentative texts from Screens 1a, 1b and 1c and formal text comprising expository and instructional elements from Screens 2a and 2b] Rating: very high	None	Reflect and evaluate: generate an evaluation of the most authoritative text, combining prior knowledge with information from three short argumentative texts and one longer expository/instructional text	Text entry response
9 (Optional)	Screen 3 Post Reply button	Post Reply button	Not applicable	Click on Post Reply

For this task, nine distinct steps are described (the last one optional). However, except for step 8, the order of the steps could be changed to achieve exactly the same result. For example, step 1 could be followed by step 3; or the sequence could begin with step 7 (but using the "Write a Reply" button shown in screen 1a, and then the "Back" button to return to the main page of the forum). There are many other possible variations in the sequence. As this task illustrates, even with this relatively restricted set of linked pages, readers in the electronic medium, to a degree, construct their own text in terms of the order in which they access and process information. The completion of step 8, for full credit, implies good navigation skills in reading electronic text (steps 1 to 7), and also strong text processing skills, since the response requires processing, integration and evaluation of multiple texts, at least one of which is quite demanding (see steps 4 and 5).

An analysis of tasks at this level of detail serves at least four functions. First, the analysis assists test developers in ensuring that the elements of the framework are reflected in the tasks and reflected in the appropriate proportions. Second, it helps in predicting the difficulty of tasks in a systematic fashion so that an appropriate range of item difficulties across the instrument is achieved. Third, the analysis is used to underpin the construction of a described proficiency scale (or scales) for reporting the results of the electronic reading assessment for PISA 2009. Fourth, the analysis will potentially contribute to research in the field by articulating what proficiency in electronic reading means, based on empirical evidence.

A fifth function, analytical scoring of text processing and navigational components, remains a potential for computer-based assessment that will not be operationalised in the main PISA 2009 analysis. The combination of data from the eight steps described in Table 1.12 could be used to determine a partial credit coding scheme for the task, where subscores could be given simply for accessing (for example) the Doctor Nauckunaite page, even if the student gained no credit for the final text-entry response. Conversely, one might consider giving full credit only to those responses with all eight steps completed (in whatever sequence).

In its present form and coding, this task could arguably be completed with minimal effort of both text processing and navigation (say, by completing only steps 1, 7 and 8). However, by the same logic, the *Student Opinions* task could be completed by reading only the last sentences of Ana's piece. We are often in the position of speculating about how test-takers actually deal with tasks cognitively. Computer-based testing offers the potential to understand much more precisely the cognitive processes – indicated by the pathways taken in navigating across the texts – that readers engage in. The technology used for the electronic reading assessment in PISA 2009 has the potential to provide information about which pages are visited and which navigation tools are used, the sequence of actions and the time spent on each item. The data collected from the electronic reading assessment will no doubt provide a rich base for research. However, given that computer-based assessment on a large-scale is at an early stage of development, scoring for this cycle will be confined to established methods.

In the electronic reading assessment, items may be coded automatically, or by experts. Considering practicality, reliability and (above all) cost, it is preferable to maximise the proportion of items that can be automatically coded, and to minimise those that require expert coding. On the other hand, since electronic reading is being conceptualised as part of the general reading framework, it is important to maintain some parallels in item format between the electronic and print instruments. Accordingly, about 30% of the electronic reading items require expert coding. See Table 1.7 for the distribution of electronic reading tasks by coding requirement and aspect.

Automatically coded items include multiple-choice items, selection of links from drop down menus, and clicks on radio buttons in the browser area.

Expert-coded items include any item involving a generated response where a degree of judgement is needed for coding. The item format for this kind of response in PISA 2009 is a text response, either within a simulated environment such as an e-mail message or blog (as in the example from *Let's Speak* shown above), or in the more transparently test-based task response area. Responses that require coding by expert coders include those for which students are asked to compare and contrast information across texts, to justify a choice by demonstrating that is satisfies prescribed conditions, or to evaluate the credibility of a source. Such items are generally used only when there is no satisfactory alternative (that is, no appropriate machine-scored alternative).

Control of the delivery of tasks in the electronic reading assessment

As the screen shots for the task from *Let's Speak* show, the interface for an electronic reading unit (a set of items related to common stimulus) has two distinct areas: a task area in the lower part of the screen, where

the question or instruction is located, and a browser area in the upper part of the screen, where the stimulus is located. The task in the task area remains fixed for the duration of an item while the student can navigate around the browser area to access different simulated web pages or applications in the course of completing a task.

In the electronic reading assessment, both units and items within units are delivered in a fixed order, or lockstep fashion. The lockstep procedure means that the students are not able to return to an item or unit once they have moved to the next item/unit. Each time students click the Next button on the test, a dialog box displays a warning that they are about to move to the next item and will be unable to return to the previous item. At this point students can either confirm they want to move on, or cancel the action and return to the item they had been viewing.

An advantage of this approach is that it maximises the independence of items within and across units, since students cannot find clues in later tasks that might help them answer earlier ones. Put more positively, later items can reveal the answers to earlier items without enabling previous answers to be changed. This feature therefore allows optimum use of a stimulus that is expensive to produce.

A further feature of the task delivery design is that the page that is visible in the browser area at the beginning of each item is fixed: that is, every student sees the same page at the beginning of a given item, regardless of where they finished the previous item. This feature contributes to item independence by ensuring that students are not given any advantage or disadvantage in relation to a new item because of where they happened to be at the end of the previous item. This design feature has also been implemented to reduce frustration, both for those students who might be lost in a simulated web environment, and for those who would otherwise have needed to retrace their steps.

Although only 19 of the PISA participating countries and economies have administered the 2009 international option of reading of electronic texts, what we have learnt about the nature of the domain and about the operational challenges and opportunities encountered in implementing a large-scale computer-delivered assessment will be shared by all OECD countries and partner economies, and will contribute to building more refined understandings that can be applied to future PISA assessments.

MOTIVATIONAL AND BEHAVIOURAL CONSTITUENTS OF READING LITERACY

Reading engagement and metacognition, which were discussed very briefly in earlier versions of the framework, are now, in the PISA 2009 cycle, given a more prominent position and more elaborated discussion, in recognition of their importance in relation to reading proficiency.

Reading engagement

Why reading engagement matters

The development of reading literacy is not confined to the development of skills and knowledge. It also involves motivation, attitude, and behaviour. Current research recognises these elements as key factors relating to reading achievement (see Guthrie & Wigfield, 2000; McKenna, Kear, & Ellsworth, 1995). Empirical studies have documented the link between reading practices and reading achievement in both adult and student populations (Campbell, Voelkl, & Donahue, 1997; Guthrie & Wigfield, 2000; OECD and STATCAN, 2000). Results from PISA 2000 show that, in every participating country, students' levels of reading engagement were positively and significantly correlated with their reading proficiencies. In fact, engagement in reading had the largest median correlation with achievement, exceeding even the median correlation between reading literacy and socio-economic status (OECD, 2002). Collectively, these and other findings point to the important role that engagement in reading can play in reducing some of the gaps seen in performance between the various subgroups in each participating country. They argue for the inclusion and even expansion of such a measure in PISA 2009.

The PISA 2009 framework for reading literacy includes the reading of electronic texts as an important part of the construct. To address the goal of measuring engagement in both paper and electronic reading, a unified framework is proposed. This framework includes two constructs: individual engagement and educational context.

The foundations of the concept of engagement lie in the self-determination theory (Ryan & Deci, 2000). This theory proposes that individuals are most well developed when they are self-determining. In this state they possess values and goals that are in tune with their culture while still being competent and confident in directing their own actions. A self-determining reader is intrinsically motivated, which refers to reading for its own sake and value. He or she reads widely for a variety of interests and purposes, and takes ownership of favourite topics or authors. A self-determining reader holds values, beliefs and goals for reading that enable him or her to pursue educational, occupational, personal and societal aims and activities.

Defining and measuring individual reading engagement in PISA

The PISA 2009 definition of individual reading engagement is as follows:

> Individual Reading Engagement refers to the motivational attributes and behavioural characteristics of students' reading.

Prominent constructs in the empirical literature on individual reading engagement include interest, perceived autonomy and social interaction. The behavioural characteristics include the amount and breadth of reading activities.

Current research suggests that engaged readers possess well-formed interests and favourite topics or types of reading material (interest); they value being in control of their reading, and self-initiate reading activities (autonomy); they rely on a social network to extend their competencies and share their knowledge and experience (social disposition); and they read frequently and widely (behaviour).

In PISA 2009, these four characteristics (each broadly interpreted) are operationalised:

- *interest in reading* – disposition to read literature and information texts for enjoyment and the satisfaction of curiosity
- *perceived autonomy* – perceived control and self-direction of one's reading activities, choices, and behaviours
- *social interaction* – social goals for reading and interactive competence
- *reading practices* – behavioural engagement referring to the amount and types of reading activities

Specifically, reading practices are defined as *the self-reported frequencies of participating in reading activities with diverse content in various media*. Importantly, readers may engage with different types of texts in different ways. They might read to gain knowledge or information; for literary experience; to perform a specific task such as retrieving a piece of information; or for social communication. While these experiences are not necessarily mutually exclusive, they can reflect real differences in how students might interact with a particular text and whether they engage with either print or electronic texts. For example, very few people acknowledge "cuddling up" with a laptop to read fiction – they much prefer to use printed materials for this type of reading. On the other hand, many people report using computer technologies for social purposes. They place a high priority on e-mail, text messaging, chat rooms, correspondence, list servers, blogs and community bulletin boards. Electronic texts seem to be used largely for social purposes.

At the lowest levels of reading engagement, as defined in PISA, students spend little time reading for pleasure or interest, read a narrow range of texts, and have little motivation to read either independently or in a social context.

Highly engaged readers, on the other hand, spend substantial amounts of time reading for enjoyment. They read a wide variety of texts in both print and electronic media, though the particular kinds of texts they read will typically vary according to gender and nationality (OECD, 2002). Such individuals not only consider reading to be valuable and interesting by nature; they also acknowledge the significant role it plays in their social relations.

The importance of educational context for reading engagement

As PISA 2009 is intended to inform educational policy, it is important to include variables that are responsive to policy decisions. One important policy-relevant variable is the classroom and school context for reading engagement.

Development of self-determination in reading evolves when individuals enjoy support for the values and behaviours of reading from significant others: people who are important to them. Initially, the parents convey the value of reading to the developing child. Reading is externally guided. Gradually, individuals internalise the goals and values that have been communicated to them by others and become convinced that reading is valuable. They may identify reading as being beneficial to their schooling and their future participation in society, although reading may not be a favourite pastime. Eventually, reading attains the status of having personal significance and becomes a preferred source of mental stimulation and emotional satisfaction.

The pathway to self-determination in reading for students depends on support from significant others. A favourable context assures competence in reading and expands autonomy in directing one's own reading activities. When the family and school context give the individual a sense of confidence (perceived competence) and autonomy (being in charge of one's self) in reading, the individual grows towards intrinsically motivated and self-determined reading.

The teacher is a "significant other" for reading literacy. A host of studies show that teachers who improve students' sense of ownership and competence enable students to become active readers who are high achievers in reading. By contrast, teachers who neglect these instructional practices undermine students' efforts to become self-directing, resulting in students who are disengaged from reading and fail to progress in reading achievement (Guthrie, 2008).

In summary, the educational context of instructional practices significantly determines students' levels of reading engagement. Given the demonstrated relation between engagement and achievement, the collection of information about classroom support for reading engagement is therefore of significant policy relevance.

Defining and measuring the educational context for reading engagement in PISA

The PISA 2009 definition of classroom support for reading engagement is as follows:

> Classroom Reading Engagement refers to the students' perceptions of support from the teacher, classroom and school for the motivational attributes and behavioural characteristics of their reading.

Two characteristics of classroom reading engagement that are operationalised in the PISA 2009 survey are relevance and autonomy support. These characteristics are aligned respectively with the characteristics of interest in reading and autonomy in the construct of individual reading engagement.

Relevance. Interest in reading is facilitated by classroom and school contexts that emphasise the relevance of texts to student background knowledge and experience (Assor, Kaplan, & Roth, 2002). When students read material that is presented as directly related to their personal interests, their comprehension is higher than if their reading is driven by a desire for test scores only (Vansteenkiste, Lens&Deci, 2006). Reading materials that are linked to immediate experience or laboratory activities are understood better than materials that are not as relevant (Guthrie, *et al*., 2006). Likewise, texts rated as "interesting" are read more thoroughly than other texts (Schiefele, 1999).

Autonomy support. Perceived autonomy, which is the major element of intrinsic motivation, is increased by classroom opportunities for choice and control (Skinner, Furrer, Marchand, & Kindermann, 2008). Teachers have a wide range of possible ways to share control with students (Flowerday & Schraw, 2000). When teachers are trained to share control, such as giving text choice or inviting input into decisions, students' classroom engagement increases (Reeve, 2004).

Collecting information about reading engagement

Items contributing to the measurement of individual reading engagement are distributed amongst questions relating to reading motivation (interest, autonomy, and social interaction) and to reading practices in both print and electronic media. Items contributing to the measurement of the educational context for reading engagement are framed in the context of questions about classroom activities.

Items measuring reading engagement appear in the Student Questionnaire, and the construct is therefore also referred to in the Questionnaire Framework (Chapter 4). The items are listed in Annex B. They are in the form

of general questions in which students report on their behaviour in described contexts. A Likert scale format (Agree/Disagree) or a question about frequency of occurrence (Never/Several times a week) is used to collect student responses.

Metacognition in reading

Why metacognition matters

Like engagement, metacognition has both a significant correlation with reading proficiency and is responsive to teaching and learning. A number of studies have found an association between reading proficiency and metacognition (Artelt, Schiefele, & Schneider, 2001; Brown, Palincsar, & Armbruster, 2004). Explicit or formal instruction of these strategies is believed to lead to an improvement in text understanding and information use. More specifically, it is assumed that the reader becomes independent of the teacher after these text processing strategies have been acquired and are applied without much effort. By using these strategies, the reader can effectively interact with the text by conceiving reading as a problem-solving task that requires the use of strategic thinking, and by thinking strategically about solving reading comprehension problems.

The general finding of the report of the U.S. National Reading Panel (2000) was that remediating poor reading literacy is possible through explicit teaching of metacognitive skills. That is, when readers are given cognitive and metacognitive strategy instruction, they make more significant gains on measures of reading comprehension than students only trained with conventional instruction procedures (Pressley, Graham, & Harris, 2006; Pressley, *et al.*, 1989; Rosenshine & Meister, 1994; Rosenshine, Meister, & Chapman, 1996).

Gathering information in PISA 2009 on those aspects of metacognition that have a demonstrated association with reading proficiency can provide the kind of information used for improving reading literacy and therefore meet one of PISA's aims: to provide policy makers with strategies for improving the educational outcomes of their students.

Defining metacognition in reading

Metacognition in reading refers to the awareness of and ability to use a variety of appropriate strategies when processing texts in a goal oriented manner. Learning from texts requires the reader to take an active role in their reading by making inferences, filling in gaps, and generating macrostructures (conceptualisations of the large-scale structure of a text) and elaborations. Engagement in such strategic activities implies an awareness of text structure and how it facilitates understanding. It is important to use both knowledge about language and texts and topic knowledge in a strategic way in order to: identify relevant information; selectively reinstate previous text information; retrieve or reinstate information from long term memory; or perform all three tasks (Baker & Brown, 1984; Borkowski & Turner, 1990; Körkel & Schneider, 1992). It also involves an understanding of the different processing demands associated with various kinds of tasks, and how to apply this understanding.

Overall, cognitive and metacognitive knowledge concerning the use of cognitive strategies in general and reading strategies in particular can be defined as mental or behavioural activities that help the learner to achieve cognitive purposes. Typically, these strategies are effort-consuming, potentially conscious, and controllable (Flavell, Miller, & Miller, 1993). For example, a reader may be taught to generate questions about a text as it is read. These questions are of the why, what, how, when, or where variety. By generating such questions and trying to answer them, the reader processes the text more actively. Other strategies relevant to different purposes of reading are various forms of highlighting and summing up important text information (identifying main ideas); frequent comprehension monitoring and self-checking; and a repertoire of approaches for dealing with text difficulties (clarifying).

Measuring metacognition in reading in PISA

The concept of reading literacy in PISA encompasses a wide variety of texts, contexts and approaches to reading that aim to give broad coverage to the many ways in which reading is important to individuals and societies in the 21st century. The focus of the metacognition construct and the items proposed for inclusion in PISA 2009 is specifically on reading to learn – that is, on reading in the educational situation (See *educational* texts under *Situation)*.

A person who intelligently uses a particular strategy should have some metacognitive knowledge of that strategy, and a person who does not use the strategy is expected to be less knowledgeable. In other words, there is a correlation between appropriate pieces of metacognitive knowledge and the effective use of strategies. Metacognitive knowledge is a prerequisite for reflective and strategic learning. Not surprisingly therefore, consistent and substantial relationships among metacognitive knowledge, strategic behaviour in a text processing task, and text recall have been found (*e.g.* Baker & Brown, 1984; Borkowski & Turner, 1990; Körkel & Schneider, 1992). Nevertheless, the relationship between metacognitive knowledge and the understanding of text in a given situation is moderated by students' actual motivation to read or to invest effort.

There is empirical evidence to suggest that there is a correlation between appropriate pieces of metacognitive knowledge and the effective use of related strategies on the one hand, and proficiency in reading on the other. An instrument measuring metacognitive knowledge about text comprehension was administered to students who took part in the PISA 2000 assessment in Germany. A correlation of $r = 0.51$ between the combined reading literacy scale and the measure of students' metacognitive knowledge was found (Artelt, Schiefele, & Schneider, 2001). Research based on PISA 2003, where such an approach was also implemented, revealed a similar correlation between metacognitive knowledge and reading literacy (Schlagmüller & Schneider, 2006). A similar measurement instrument is being administered in PISA 2009.

Collecting information about metacognition

In the PISA 2009 assessment, a number of reading scenarios (short vignettes) are presented to students. For each scenario, students are asked to evaluate the quality and usefulness of different reading and text comprehension strategies for reaching the intended goal.

The rank order of strategies for each scenario is compared with an "optimal" rank order developed by experts in the field of text processing (reading researchers, teachers and educational psychologists). The correspondence between the rankings of experts and students is reflected in a metacognition score indicating the degree to which students are aware of the best ways of storing text information and understanding memory and comprehension goals. In order to achieve high scores on the metacognition test, students must activate knowledge about cognitive resources, the nature of the task, and strategies that facilitate understanding, remembering and recalling of information.

An example of a metacognition task that was administered in the field trial for PISA 2009 is provided below.

Q Reading task: You want to help a 12-year-old student to understand a three-page text about animals and plants of the forest.

How do you rate the usefulness of the following strategies for helping the 12-year old student to understand the three-page text?

	Possible strategy	Score					
		Not useful at all				Very useful	
		(1)	(2)	(3)	(4)	(5)	(6)
a)	First the 12-year-old student writes a summary of the text. After that we check together whether the summary covers the most important points	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
b)	I ask the 12-year-old student to read the text out loud twice, and then to copy it out	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
c)	After the 12-year-old student has read the text aloud, we discuss difficult words that he did not understand	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
d)	I provide a second text about the same topic which we read together immediately after reading the first one.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
e)	I read the text aloud while the 12-year-old student underlines words he doesn't understand. I then try to help him clear up what he doesn't understand. Then he writes a summary.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
f)	The 12-year-old student reads the text aloud and I correct him whenever he makes a mistake. Then I explain the meaning of the words that he did not read correctly.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

Expert raters judge strategies a), c) and e) to be more effective than strategies b), d) and f) in helping a younger student to understand information in a text book. Accordingly, the more closely a student approximated the experts' ratings of the strategies in this item – a), c), e) > b) ,d), f) – the higher the student scored. For example, if a student rated the six strategies respectively as a)6; b)3; c)5; d)3; e)6 and f)1, that student would receive a high score for the item. Conversely a student who, for example, gave the highest rating to strategy f) would receive a low score for this item. In the field trial, performance on this item showed a strong correlation with performance in the cognitive reading assessment. In other words, students who achieved a high score on this metacognition item tended to do well overall on the PISA reading assessment.

REPORTING PROFICIENCY IN READING

PISA reports in terms of proficiency scales which are interpretable in policy terms. In PISA 2000, when reading was the major domain, the results of the reading literacy assessment were first summarised on a single composite reading literacy scale having a mean of 500 and a standard deviation of 100. In addition to the composite scale, student performance was also represented on five subscales: three process (aspect) subscales (retrieving information, interpreting texts and reflection and evaluation) and two text format subscales (continuous and non-continuous) (OECD, 2001, 2002). These five subscales make it possible to compare mean scores and distributions among subgroups and countries by various components of the reading literacy construct. Although there is a high correlation between these subscales, reporting results on each subscale reveals interesting interactions among the participating countries. Where such interactions occur, they can be examined and linked to the curriculum and teaching methodology used. In some countries, the important question may be how to teach the current curriculum better. In others, the question may not only be how to teach but also what to teach.

In both PISA 2003 and 2006, when reading was a minor domain, and fewer reading items were administered to participating students, a single reading literacy trend scale was reported based upon the overall composite scale (OECD, 2004). In PISA 2009, reading is again the major domain, as it was in 2000. A reporting scheme using a number of subscales as well as a composite scale can therefore be anticipated.

Interpreting and using the data

The reading literacy tasks are constructed and administered to nationally representative samples of 15-year-old students in participating countries to ensure that the assessment provides the broadest possible coverage of the domain as defined here. However, no individual student can be expected to respond to the entire set of tasks. Accordingly, the survey is designed to give each student participating in the study a subset of the total pool of tasks, while at the same time ensuring that each of the tasks is administered to nationally representative samples of students.

Reading literacy tasks are arranged along a scale that indicates progressively the level of difficulty for students and the level of skill required to answer each item correctly. The scale summarises both the proficiency of a person in terms of his or her ability and the complexity of an item in terms of its difficulty.

Reading literacy tasks used in PISA vary widely in situation, text format, and task requirements, and they also vary in difficulty. This range is captured through what is known as an item map. The item map provides a visual representation of the reading literacy skills demonstrated by students at different points along the scale. The map contains a brief description of a selected number of released assessment tasks along with their scale values. These descriptions take into consideration the specific skills that the item is designed to assess and, in the case of open-ended tasks, the criteria used for judging the item correct. An examination of the descriptions provides some insight into the range of processes required of students and the proficiencies they need to demonstrate at various points along the reading literacy scale. An item map (or maps) will be built to illustrate what progress means along the scale (or scales) developed for PISA 2009.

Levels of reading literacy proficiency

Just as students within each country are sampled to represent the national population of 15-year-old students, each reading literacy task represents a class of tasks from the reading literacy domain. Tasks at the lower end of the reading scale and subscales differ from those at the higher end. Difficulty is in part determined by the length, structure and complexity of the text itself. However, while the structure of a text contributes to the difficulty of an item, what the reader has to do with that text, as defined by the question or instruction, interacts with the text and affects the overall difficulty. A number of variables that can influence the difficulty of any reading literacy task have been identified, including the complexity and sophistication of the mental processes integral to the aspect of the task (retrieving, interpreting or reflecting), the amount of information to be assimilated by the reader and the familiarity or specificity of the knowledge that the reader must draw on both from within and

from outside the text. In an attempt to capture this progression of complexity and difficulty in PISA 2000, the composite reading literacy scale and each of the subscales were divided into five levels:

Level	Score points on the PISA scale
5	More than 625
4	553 to 625
3	481 to 552
2	408 to 480
1	335 to 407
Below level 1	Less than 335

These levels appear to be a useful way to explore the progression of reading literacy demands within the composite scale and each subscale.

The scale summarises both the proficiency of a person in terms of his or her ability and the complexity of an item in terms of its difficulty. The mapping of students and items on one scale represents the idea that students are more likely to be able to successfully complete tasks mapped at the same level on the scale (or lower), and less likely to be able to successfully complete tasks mapped at a higher level on the scale.

It is expected that these levels as they were defined for PISA 2000 will be kept for the composite scale used to measure trends. For PISA 2009, newly constructed items will help to improve descriptions of the existing levels of performance and, ideally, furnish descriptions of levels of performance above and below those established in PISA 2000.

Given the top of the reading literacy scale currently has no bounds, there is arguably some uncertainty about the upper limits of proficiency of extremely high performing students. However such students are likely to be capable of performing tasks characterised by the highest level of proficiency. For students who are at the bottom end of the reading literacy scale there is a greater issue. Although it is possible to measure the reading proficiency of students performing below Level 1, at this stage their proficiency cannot be described. Level 1 begins at 335, yet a certain and significant percentage of students in each country is estimated to be below this point on the scale. In developing new material for PISA 2009 an effort has been made to design items that measure reading skills and understandings located below the current Level 1. The intention will be to describe what those skills and understandings are, and possibly to define one or more levels below Level 1. (See the first two paragraphs under *Extending the descriptive power of the PISA scales by manipulating item difficulty*).

Reporting PISA 2009 reading literacy

The new framework for reading literacy extends the domain to include both printed and electronic texts. Reporting therefore becomes a little more complicated. It will be important to maintain both the original composite scale and subscales to measure trends based on printed texts. These will be the same scales that were used to report PISA 2000 data and they will be relevant to all participating countries.

Table 1.13 below shows the proposed scales and subscales for print reading that will provide trend data for PISA 2000, 2003, 2006 and 2009. The cells are numbered 1 to 5 to facilitate discussion. Note that each task will be classified both by aspect and by text format.

Table 1.13 **Reporting results on print reading instruments**

Aspect	Access and retrieve (previously called Retrieving information)	1
	Integrate and interpret (previously called Interpreting texts)	2
	Reflect and evaluate (previously called Reflection and evaluation)	3
Text format	Continuous	4
	Non-continuous	5

The cells numbered 1 to 3 represent groups of tasks categorised by aspect. These three cells together include all the print reading tasks. A composite scale (1+2+3) will be built to describe performance on the full set of print items, and subscales will be extracted based on the tasks for each of the aspects (separate subscales based on 1, 2 and 3 respectively).

The cells numbered 4 and 5 represent tasks classified as continuous and non-continuous respectively. Subscales will be extracted from the composite scale (1+2+3) based on these two text formats. A small number of print reading tasks will be classified as mixed or multiple by text format; however there are too few of these tasks to constitute separate subscales (see Table 1.2). Mixed- and multiple-text tasks will therefore not contribute to the text-format subscales, though they will contribute to the print composite scale and aspect subscales.

The composite scale based on 1+2+3, and the subscales 1, 2, 3, 4 and 5 will be statistically equated with scales and subscales developed for PISA 2000, and will therefore form the basis for reporting trends. Though they will have different names, the aspect subscales will be directly comparable with the aspect subscales reported in PISA 2000.

For those countries that have chosen to implement the assessment of electronic reading an additional scale based only on electronic reading tasks will be created, therefore starting a new trend line. In addition, the possibility of constructing an overall PISA reading literacy scale combining information from the print and electronic reading assessments will be investigated through analysis of the main survey data. Should it be demonstrated that it is valid to combine data from the print and electronic reading assessments, the possibility of constructing aspect subscales across the media will also be considered within countries. It may become apparent, however, that performances on print and ERA tasks are not highly enough correlated to support the construction of an overall scale and subscales. This kind of result will also be of great interest to participating countries, suggesting further investigation of which elements of reading in the two media draw on different understandings and knowledge, and perhaps pointing to differential levels of proficiency among subgroups (for example, males and females).

Table 1.14 represents the components of print and electronic reading assessments that might be combined in different ways to form scales and subscales.

Table 1.14 **Reporting results across print and electronic reading instruments**

Aspect	Print reading	Electronic reading
Access and retrieve	1	6
Integrate and interpret	2	7
Reflect and evaluate	3	8
Complex		9

The cells numbered 1 to 3 represent the same sets of items as those numbered 1 to 3 in Table 1.13. Cells 6 to 8 represent the set of electronic reading items that can be classified according to a single aspect: access and retrieve, integrate and interpret, or reflect and evaluate. The cell numbered 9 represents complex electronic reading tasks: those that combine all three aspects inextricably.

As well as the composite print scale and the five print subscales described above, for countries participating in the electronic reading international option, a scale based on tasks from cells 6 to 9 will be constructed. In addition, the following will be investigated: a composite reading scale across print and electronic media (1+2+3+6 +7+8+9); a composite access and retrieve subscale (1+6); a composite integrate and interpret scale (2+7) and a composite reflect and evaluate scale (3+8). The construction of the cross-media scale and subscales will depend on empirical support for the theory that there is a high correlation between proficiency in print reading and electronic reading, and within each aspect of reading across the two media.

Separate subscales for electronic reading independent of print reading will not be constructed, as there will be too few items in the elecronic reading assessment instrument on which to base meaningful subscale reporting.

CONCLUSION

An essential concern of PISA is to provide information to policy makers about trends over time. In light of that, the analysis of trends must be given priority in any reporting plans, and this will be ensured in PISA 2009 by the construction of a scale and subscales that are based entirely on print reading tasks. A different set of scales will be built to report on the electronic reading assessment and, where possible, to report the combined results of print and electronic reading assessments, therefore providing the basis for establishing new trend lines for future cycles. In anticipating a range of options for reporting, the PISA reading literacy framework and assessment are designed to provide an array of data capable of richly informing the work of policy makers, educators, and researchers.

The construct of reading literacy that has been described in this document preserves many of the principles and operational features of PISA 2000, while also introducing new perspectives on reading literacy. An important addition for PISA 2009 is the inclusion of motivational and behavioural components in the definition and description of reading literacy. The notion of reading literacy in PISA therefore goes beyond the simple measurement of a student's capacity to decode and understand literal information. Reading literacy in PISA also involves understanding, using, reflecting on and engaging with written texts, both to achieve personal goals and to participate actively in society.

Notes

1. The discussion in this section refers to reading in both the print and electronic media, unless otherwise stated.

2. This does not preclude the use of several texts in a single task, but each of the texts should itself be coherent.

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2

PISA 2009 Mathematics Framework

This chapter begins with PISA's definition of mathematics and explains the theory underlying the development of the assessment. The PISA mathematics assessment is organised into many different categories: situations or contexts; mathematical content and mathematical competencies. It also includes four overarching ideas: space and shape; change and relationships; quantity and uncertainty. The chapter describes the processes and competencies needed to solve PISA mathematics questions and explains the categorisation of the three competency clusters: reproduction, connections and reflections. It uses sample tasks from the PISA assessment to further illustrate the framework and then discusses how proficiency in mathematics is measured for the analysis and reporting of results.

INTRODUCTION

This framework describes and illustrates the PISA mathematics assessment. The term *mathematical literacy* is used to highlight that the PISA mathematics assessment is concerned with the reproduction of mathematical knowledge and in addition, in solving the PISA assessment tasks, students are typically required to extrapolate from what they have learned in school and to apply mathematical knowledge to authentic problems situated in a variety of contexts. The mathematical processes needed to do this, which are based on mathematical knowledge and skills, are referred to as cognitive mathematical competencies. The major components of the mathematics framework, consistent with the other PISA frameworks, include contexts for the use of mathematics, mathematical content and mathematical processes, each of which flow directly out of the definition of the domain. The discussions of context and content in this chapter emphasise features of the problems that confront students as citizens, while the discussions of processes emphasise the mathematical knowledge and skills that students employ to solve those problems. These processes have been grouped into three clusters to facilitate a rational treatment of the way complex cognitive processes are addressed within a structured assessment programme.

DEFINITION OF THE DOMAIN

The PISA *mathematics* domain is concerned with the ability of students to analyse, reason and communicate ideas effectively as they pose, formulate, solve and interpret mathematical problems in a variety of situations. The PISA mathematics assessment focuses on real-world problems, moving beyond the kinds of situations and problems typically encountered in school classrooms. In real-world settings, citizens routinely face situations in which the use of quantitative or spatial reasoning or other cognitive mathematical competencies would help clarify, formulate or solve a problem. Such situations include shopping, travelling, cooking, dealing with personal finances, judging political issues, etc. Such uses of mathematics are based on the skills learned and practised through the kinds of problems that typically appear in school textbooks and classrooms. However, they also demand the ability to apply those skills in a less structured context, where the directions are not so clear, and where the student must make decisions about what knowledge may be relevant and how it might be usefully applied.

Citizens in every country are increasingly confronted with a myriad of tasks involving quantitative, spatial, probabilistic and other mathematical concepts. For example, media outlets (newspapers, magazines, television and the Internet) are filled with information in the form of tables, charts and graphs about subjects such as weather, climate change, economics, population growth, medicine and sports, to name a few. Citizens are also confronted with the need to read forms, interpret bus and train timetables, successfully carry out transactions involving money, determine the best buy at the market, and so on. The PISA mathematics assessment focuses on the capacity of 15-year-old students (the age when many students are completing their formal compulsory mathematics learning) to use their mathematical knowledge and understanding to help make sense of these issues and carry out the resulting tasks.

PISA defines *mathematical literacy* as:

> …an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen.

Some explanatory remarks may help to further clarify this domain definition:

- The term *mathematical literacy* emphasises mathematical knowledge put to functional use in a multitude of different situations in varied, reflective and insight-based ways. Of course, for such use to be possible and viable, many fundamental mathematical knowledge and skills are needed. Literacy in the linguistic sense presupposes, but cannot be reduced to, a rich vocabulary and substantial knowledge of grammatical rules, phonetics, orthography, etc. To communicate, humans combine these elements in creative ways in response to each real-world situation encountered. In the same way, mathematical literacy presupposes, but cannot be reduced to, knowledge of mathematical terminology, facts and procedures, as well as skills in performing certain operations and carrying out certain methods. It involves the creative combination of these elements in response to the demands imposed by external situations.

- The term "the world" refers to the natural, social and cultural setting in which the individual lives. As Freudenthal (1983) states: "Our mathematical concepts, structures, ideas have been invented as tools to organise the phenomena of the physical, social and mental world" (p. ix).
- The phrase "to use and engage with" is meant to cover the usage of mathematics and solving mathematical problems, and also implies a broader personal involvement through communicating, relating to, assessing, and even appreciating and enjoying mathematics. Thus, the definition of *mathematical literacy* encompasses the functional use of mathematics, in a narrow sense, as well as preparedness for further study and the aesthetic and recreational elements of mathematics.
- The phrase "that individual's life" includes his or her private life, occupational life and social life with peers and relatives, as well as his or her life as a citizen of a community.

A crucial capacity implied by this notion of *mathematics* is the ability to pose, formulate, solve and interpret problems using mathematics within a variety of situations and contexts. The contexts range from being purely mathematical to having no mathematical structure present or apparent at the outset – the problem poser or solver must successfully introduce the mathematical structure. It is also important to emphasise that the definition is not just concerned with knowing mathematics at some minimal level; it is also about doing and using mathematics in situations that range from the everyday to the unusual, from the simple to the complex.

THEORETICAL BASIS FOR THE PISA MATHEMATICS FRAMEWORK

The PISA definition of *mathematical literacy* is consistent with the broad and integrative theory about the structure and use of language as reflected in recent socio-cultural literacy studies. In James Gee's *Preamble to a Literacy Program* (1998), the term "literacy" refers to the human use of language. The ability to read, write, listen and speak a language is the most important tool through which human social activity is mediated. In fact, each human language and use of language has an intricate design tied in complex ways to a variety of functions. Being literate in a language implies that a person knows many of the design resources of the language and is able to use those resources for several different social functions. Analogously, considering mathematics as a language implies that students must learn the design features involved in mathematical discourse (the terms, facts, signs and symbols, procedures and skills to perform certain operations in specific mathematical sub-domains, and the structure of those ideas in each sub-domain), and they also must learn to use such ideas to solve non-routine problems in a variety of situations defined in terms of social functions. Note that the design features for mathematics include knowing the basic terms, procedures and concepts commonly taught in schools, and also involve knowing how these features are structured and used. Unfortunately, one can know a good deal about the design features of mathematics without knowing either their structure or how to use those features to solve problems. These scholarly notions involving the interplay of design features and functions that support the mathematics framework for PISA can be illustrated in the following example.

MATHEMATICS EXAMPLE 1: HEARTBEAT

For health reasons people should limit their efforts, for instance during sports, in order not to exceed a certain heartbeat frequency.

For years the relationship between a person's recommended maximum heart rate and the person's age was described by the following formula:

Recommended maximum heart rate = 220 – age

Recent research showed that this formula should be modified slightly. The new formula is as follows:

Recommended maximum heart rate = 208 – (0.7 × age)

The questions in this unit centre around the difference between the two formulae and how they affect the calculation of the maximum allowable heart rate.

Question 1: HEARTBEAT

A newspaper article stated: "A result of using the new formula instead of the old one is that the recommended maximum number of heartbeats per minute for young people decreases slightly and for old people it increases slightly."

From which age onwards does the recommended maximum heart rate increase as a result of the introduction of the new formula? Show your work.

Question 1 can be solved by following the general strategy used by mathematicians, which the mathematics framework will refer to as "mathematising". Mathematising can be characterised as having five aspects:

- *First, the process of mathematisation or mathematising starts with a problem situated in reality.*

As will be clear from the item, the issue situated in reality in this case is physical health and fitness: "An important rule when exercising is that one should be careful to not push oneself too far as excessive exertion may cause health problems." The question alerts us to this issue through the text linking health to heart rate and by referring to the "recommended maximum heart rate".

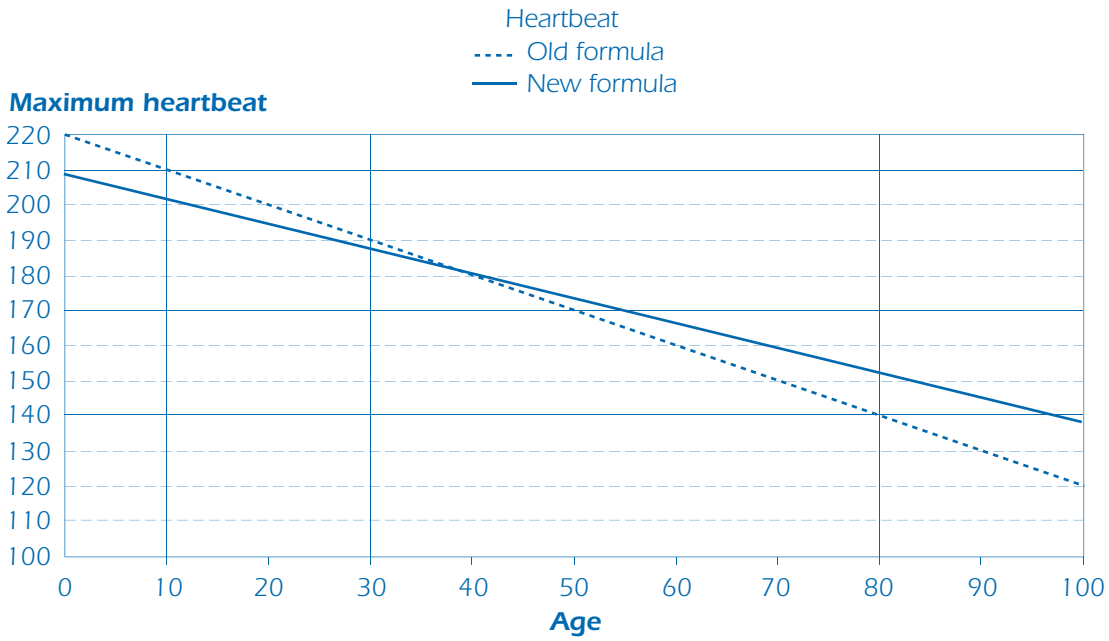
- *Secondly, the problem solver tries to identify the relevant mathematics, and reorganises the problem according to the mathematical concepts identified.*

It seems clear that the student faces two word formulae that need to be understood, and he or she is requested to compare these two formulae and determine what they mean in mathematical terms. The formulae give a relation between the advised maximum heart beat rate and the age of a person.

- *The third step involves gradually trimming away the reality.*

There are different ways of refocusing the problem to be a strictly mathematical problem, or of trimming away reality. One way would be to make the word formulae into more formal algebraic expressions like $y = 220 - x$ or $y = 208 - 0.7x$. The student must remember that y expresses the maximum heart beat in beats per minute and x represents the age in years. Another strictly mathematical approach would be to draw the graphs directly from the word formulae. These graphs are straight lines as the formulae are of the first degree. The graphs have different slopes, so they intersect.

These three steps lead one from a real-world problem to a mathematical problem.



■ *The fourth step is solving the mathematical problem.*

The mathematical problem at hand is to compare the two formulae, or graphs, and say something about the differences for people of a certain age. A nice way to start is to find out where the two formulae give equal results, or where the two graphs intersect. The student can find this by solving the equation: $220 - x = 208 - 0.7x$. This gives us $x = 40$ and the corresponding value for y is 180. So the two graphs intersect at the point (40, 180). This point can also be found in the graph just above. As the slope of the first formula is -1 and the second is -0.7, the student knows that the second graph is less steep than the first. The student also knows that the graph line of $y = 220 - x$ lies above the graph line of $y = 208 - 0.7x$ for values of x smaller than 40 and lies below for values of x larger than 40.

■ *The fifth asks what the meaning of this strictly mathematical solution is in terms of the real world.*

The meaning is not too difficult if the student realises that x is the age of a person and y the maximum heart beat. If one is 40 years old both formulae give the same result: a maximum heartbeat of 180. The 'old' rule allows for higher heart rates for younger people: in the extreme, if the age is zero the maximum is 220 in the old formula and only 208 in the new formula. But for older people, in this case for those over 40, the more recent insights allow for higher maximum heartbeat; as an example: for an age of 100 years the student sees that the old formula gives him or her a maximum of 120 and the new one 138. Of course the student has to realise a number of other things: the formulae lack mathematical precision and are only quasi scientific. In reality, the formulae provide only a rule of thumb that should be used with caution. Moreover the outcomes for ages at the extreme should be regarded even more cautiously.

What this example shows is that even with items that seem relatively simple in the sense that they can be used within the restrictions of a large international study and solved in a short time, the full cycle of mathematisation and problem solving can still be identified.

It is these processes that characterise how, in a broad sense, mathematicians often do mathematics, how people use mathematics in a variety of current and potential occupations, and how informed and reflective citizens should use mathematics to fully and competently engage with the real world. In fact, learning to mathematise should be a primary educational goal for all students.

Today and in the foreseeable future, every country needs mathematically literate citizens to deal with a very complex and rapidly changing society. Accessible information has been growing exponentially and citizens need to be able to decide how to deal with this information. Social debates increasingly involve quantitative information to support claims. Individuals often need to be mathematically literate to make judgements and assess the accuracy of conclusions and claims in surveys and studies. Being able to judge the soundness of the claims from such arguments is, and increasingly will be, a critical aspect of being a responsible citizen. The steps of the mathematisation process discussed in this framework are fundamental for one to use mathematics in such complex situations. Failure to use mathematical notions can result in confused personal decisions, an increased susceptibility to pseudo-sciences, and poorly informed decision-making in professional and public life.

A mathematically literate citizen understands how quickly change is taking place and the consequent need to be open to lifelong learning. Adapting to these changes in a creative, flexible and practical way is a necessary condition for successful citizenship. The skills learned at school will probably not be sufficient to serve the needs of citizens for the majority of their adult life.

The requirements for competent and reflective citizenship also affect the workforce. Workers are less frequently expected to carry out repetitive physical chores. Instead, they are engaged actively to monitor output from a variety of high-technology machines, deal with a flood of information and engage in team problem solving. In the future more occupations will require the ability to understand, communicate, use and explain concepts and procedures based on mathematical thinking. The steps of the mathematisation process are the building blocks of this kind of mathematical thinking.

Mathematically literate citizens also develop an appreciation for mathematics as a dynamic, changing and relevant discipline that may often serve their needs.

The operational problem faced by PISA is how to assess whether 15-year-old students are mathematically literate in terms of their ability to mathematise. Unfortunately, in a timed assessment this is difficult because most complex real situations demand a considerable amount of time for one to collaborate and find appropriate resources while proceeding from reality to mathematics and back.

To illustrate mathematisation in an extended problem-solving-exercise, consider the following HOLIDAY example, which was an item in the PISA 2003 problem-solving survey. The problem poses two questions to the students. It deals with the planning of a route and places to stay overnight on a holiday trip. Students were presented with a simplified map and a chart (multiple representations) showing the distances between the towns illustrated on the map.

MATHEMATICS EXAMPLE 2: HOLIDAY

This problem is about planning the best route for a holiday.

Figures A and B show a map of the area and the distances between towns.

Figure A. Map of roads between towns

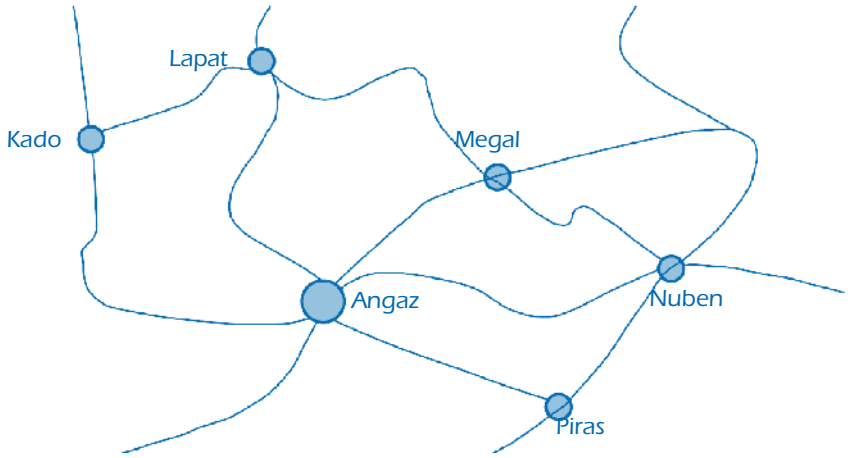


Figure B. Shortest road distance of towns from each other in kilometres

Angaz						
Kado	550					
Lapat	500	300				
Mergal	300	850	550			
Nuben	500		1000	450		
Piras	300	850	800	600	250	
	Angaz	Kado	Lapat	Megal	Nuben	Piras

Question 1: HOLIDAY

Calculate the shortest distance by road between Nuben and Kado.

Distance: ..... kilometres.

Question 2: HOLIDAY

Zoe lives in Angaz. She wants to visit Kado and Lapat. She can only travel **up to 300 kilometres** in any one day, but can break her journey by camping overnight anywhere between towns.

Zoe will stay for two nights in each town, so that she can spend one whole day sightseeing in each town.

Show Zoe's itinerary by completing the following table to indicate where she stays each night.

Day	Overnight Stay
1	Camp-site between Angaz and Kado
2	
3	
4	
5	
6	
7	Angaz

While there is no obvious link to a curricular discipline, there is a clear relation to discrete mathematics. There is also not a pre-described strategy to solve this problem. Often, students know exactly which strategy to use when posed a problem-solving exercise. But in real-world problem solving there is no well-known strategy available.

This example also clearly presents the five aspects of mathematising. The problem is situated in reality and can be organised according to mathematical concepts (distance tables or matrices) and maps (as models of reality.) Additionally, the student is required to trim away redundant information and focus on relevant information, especially on the mathematical aspects of that information. Finally, the student needs to solve the problem in mathematical terms then reflect on the solution in terms of the real situation.

Although there is relatively little reading required to solve the problem, it is still rather complex because students must read and interpret information from the map and the distance chart. Some of the distances that they have to find in the chart require them to read distances starting from the bottom of the chart and some starting from the left. For example, in determining the distance from Nuben to Piras, one needs to transform the search to that of finding the distance from Piras to Nuben (OECD, 2004).

The second question sets a number of constraints that needed to be complied with simultaneously: a maximum of 300 kilometres travelled in a given day, starting and finishing in Zoe's hometown of Angaz, visiting Kado and Lapat, and staying two nights in each of these cities so that she can achieve her vacation goals.

It should be noted than in the PISA problem-solving survey from which this item was taken, students were allowed considerably more time to find answers than normally allowed for the typically shorter mathematics items.

Ideally, to judge whether 15-year-old students can use their accumulated mathematical knowledge to solve mathematical problems they encounter in their world, one would collect information about the students' abilities

to mathematise such complex situations. Since this is not a feasible option though, PISA instead prepares items to assess different parts of this process. The following section describes how a set of test items are created in a balanced manner so that all five aspects of mathematising are covered in the selection. The aim is to use the responses to those items to locate students on a scale of proficiency in the PISA assessment of mathematics

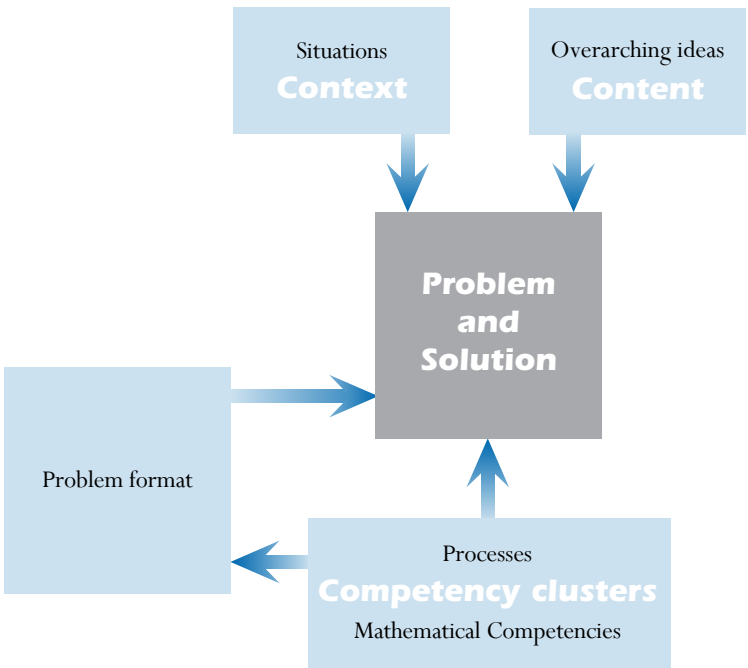
ORGANISATION OF THE DOMAIN

The PISA mathematics framework describes and provides the rationale for an assessment that examines how 15-year-old students handle mathematics in a well-founded manner when confronted with real-world problems, or more generally an assessment of how mathematically literate 15-year-old students are. To describe the domain more clearly, three components must be distinguished:

- the *situations or contexts* in which the problems are located;
- the *mathematical content* used to solve the problems, organised by certain overarching ideas;
- the *mathematical competencies* that must be activated to connect the real world, in which the problems are generated, with mathematics, and thus to solve the problems.

These components are represented in Figure 2.1. An explanation of each is provided afterwards.

Figure 2.1 ■ **The components of the mathematics domain**



A person's *mathematical literacy* is seen in the way he or she uses mathematical knowledge and skills to solve problems. Problems (and their solutions) may occur in a variety of situations or contexts within the experience of an individual. PISA problems draw from the real world in two ways. First, problems exist within some broad situations that are relevant to the student's life. The situations form part of the real world and are indicated by a big square in the upper left-hand corner of Figure 2.1. Next, within that situation, problems have a more specific context. This is represented by the grey rectangle in the situations square.

In the *HEARTBEAT* and *HOLIDAY* examples, both situations are the personal real world, and the contexts are sport/health aspects for the active citizen and planning a holiday.

To solve real world problems such as these, a person must apply his or her knowledge of specific technical

mathematical content. Unlike a classroom situation, where the mathematical content under study is usually evident, typically the knowledge required when solving real-world problems is not immediately evident. The problem solver must engage with the phenomena through which the problem is presented, must identify what specific knowledge will likely be useful, and must activate that knowledge.

PISA therefore identifies mathematical content by listing a small set of *overarching ideas* that represent broad categories of real-world phenomena through which opportunities to explore and use mathematics arise in our interactions with the world. This approach reflects the main threads in both the historical development of mathematics as a discipline, and the development of mathematical ideas in individuals. Those four broad categories are also elaborated to show the more specific mathematical objects, knowledge and skills typically used in relation to each, thereby showing the links between this approach to specifying mathematical content, and the topics covered in school mathematics curricula.

The *overarching ideas* are represented by the big square in the upper right-hand corner of Figure 2.1. From the overarching ideas, the particular mathematical content used in solving a problem is extracted. This is represented by the smaller square within the overarching ideas square.

The arrows going from the context and content to the problem show how the real world (including mathematics) makes up a problem.

The *HEARTBEAT* problem involves mathematical relations and comparing two relations in order to make decisions. Thus, the problem belongs to the overarching idea *change and relationships*. The *HOLIDAY* problem requires some basic computation, and while the second question requires some analytic reasoning, the most appropriate overarching idea is *quantity*.

Cognitive mathematical competencies are the mathematical processes that students apply as they attempt to solve problems. They encapsulate the different cognitive processes needed to solve various kinds of problems. The individual mathematical competencies as defined in the competency clusters reflect the way that mathematical processes are typically employed when solving problems that arise as students interact with their world. They will be described in detail in later sections.

Thus the process component of this framework is represented first by the large square, representing the general mathematical competencies, and, inside that, a smaller square that represents the three clusters. The mathematical processes or competencies needed to solve a particular problem are related to the nature of the problem, and the competencies used will be reflected in the solution found. This interaction is represented by the arrow from the box containing the mathematical processes to the box containing the problem and its solution.

The remaining arrow in the diagram goes from the box containing the mathematical processes to the box containing the problem format. The mathematical processes used to solve a problem are related to the form of the problem and its precise demands.

It should be emphasised that the three components just described are of different natures. Indeed, the mathematical processes are the core of the mathematics assessment, and students will only be in a position to successfully solve problems when certain competencies are available to them. Assessing *mathematical literacy* includes assessing to what extent students possess mathematical knowledge and skills that they can productively apply in problem situations.

In the following sections, these three components are described in more detail.

Situations and context

An important aspect of *mathematical literacy* is engagement with mathematics: using and doing mathematics in a variety of situations. It has been recognised that in dealing with issues that call for mathematical treatment, the choice of mathematical methods and representations is often dependent on the situations in which the problems are presented.

The situation is the part of the student's world in which the tasks are placed. It is located at a certain distance from the students. For PISA, the closest situation is the student's personal life. Next is school life, work life and leisure, followed by the local community and society as encountered in daily life. Scientific situations are furthest away. The four situation types defined and used for problems to be solved are: personal, educational/occupational, public and scientific.

The context of an item is its specific setting within a situation. It includes all the detailed elements used to formulate the problem.

Consider the following example:

MATHEMATICS EXAMPLE 3: SAVINGS ACCOUNT

Question 1: SAVINGS ACCOUNT

1 000 zed is put into a savings account at a bank. There are two choices: one can get an annual rate of 4% OR one can get an immediate 10 zed bonus from the bank, and a 3% annual rate.

Which option is better after one year? After two years?

The situation of this item is finance and banking, a situation from the local community and society that PISA would classify as public. The context of this item concerns money (zeds) and interest rates for a bank account.

This kind of problem is one that could be part of the actual experience or practice of the participant in some real-world setting. It provides an authentic context for the use of mathematics, since the application of mathematics in this context would be genuinely directed to solving the problem. This can be contrasted with problems frequently seen in school mathematics texts, where the main purpose is to practise the mathematics involved rather than to use mathematics to solve a real-world problem. This authenticity in the use of mathematics is an important aspect of the design and analysis of items for PISA, strongly related to the definition of *mathematical literacy*.

It should be noted that this use of the term authentic is not intended to indicate that mathematics items are genuine or real. PISA mathematics uses the term authentic to indicate that the use of mathematics is genuinely directed to solving the problem at hand, rather than the problem being merely a vehicle for the purpose of practising some mathematics.

One should also note that some elements of the problem are made up, namely the money involved, the zeds. This fictitious element is introduced to ensure that students from certain countries are not given an unfair advantage.

The situation and context of a problem can also be considered in terms of the distance between the problem and the mathematics involved. If a task refers only to mathematical objects, symbols or structures, and makes no reference to matters outside the mathematical world, the context of the task is considered to be intra-mathematical, and will be classified as belonging to the scientific situation type. A limited range of such tasks is included in PISA, where the close link between the problem and underlying mathematics is made explicit in the problem context. More typically, problems encountered in the day-to-day experience of the student are not stated in explicit mathematical terms. They refer to real-world objects. These task contexts are extra-mathematical and the student must translate these problem contexts into a mathematical form. Generally speaking, PISA puts an emphasis on tasks that might be encountered in some real-world situations and possess an authentic context for the use of mathematics that influences the solution and its interpretation. This, however, does not preclude the inclusion of tasks in which the context is hypothetical, as long as it has some real elements, is not too far removed from a real-world situation, and requires an authentic use of mathematics to solve the problem. Example 4 shows a problem with a hypothetical context that is extra-mathematical.

MATHEMATICS EXAMPLE 4: COINAGE SYSTEM

Question 1: COINAGE SYSTEM

Would it be possible to establish a coinage system based on only the denominations 3 and 5? More specifically, what amounts could be reached on that basis? Would such a system be desirable?

This problem does not necessarily derive its quality from its closeness to the real world; rather, it is mathematically interesting and calls on mathematical processes that are related to *mathematical literacy*. The use of mathematics to explain hypothetical scenarios and explore potential systems or situations is one of the most powerful features of this example, even if its actual scenarios or systems are unlikely to be carried out in reality. Such a problem would be classified as belonging to the scientific situation type.

In summary, PISA places most value on tasks that could be encountered in a variety of real-world situations and have a context in which the use of mathematics to solve the problem would be authentic. Problems with extra-mathematical contexts that influence the solution and its interpretation are preferred as a vehicle for assessing mathematics since these problems are most like those encountered in day-to-day life.

Mathematical content – the four overarching ideas

Mathematical concepts, structures and ideas have been invented as tools to understand, organise, and analyse the phenomena of the natural, social and mental world. In schools, the mathematics curriculum has been logically organised around content strands (*e.g.*, arithmetic, algebra, geometry) and their detailed topics that reflect historically well-established branches of mathematical thinking, and that facilitate the development of a structured teaching syllabus. However, in the real world the phenomena that lend themselves to mathematical treatment do not come so logically organised. Rarely do problems arise in ways and contexts that allow their understanding and solution to be achieved through the application of knowledge from a single content strand, and solving problems as they appear in the real world usually requires an expanded range of thought processes compared with those typically employed in the classroom.

Since the goal of PISA is to assess students' capacity to solve real problems, our strategy has been to define the range of content that will be assessed using a phenomenological approach to describing mathematical concepts, structures or ideas. This means describing content in relation to the phenomena and the kinds of problems for which it was created. This approach ensures a focus in the assessment that is consistent with the domain definition, yet covers a range of content that includes what is typically found in other mathematics assessments and in national mathematics curricula.

A phenomenological organisation for mathematical content is not new. Two well known publications *On the Shoulders of Giants: New Approaches to Numeracy* (Steen, 1990) and *Mathematics: The Science of Patterns* (Devlin, 1994) have described mathematics in this manner. Various terms and categorisations have been used in these and other similar publications. A choice is needed, and for PISA four have been chosen. The overarching ideas used for PISA assessment purposes reflect an understanding of the mathematics field that focuses on patterns. Patterns in *quantity*, patterns in *space and shape* and patterns in *change and relationships* form central and essential concepts for any description of mathematics, and they form the heart of any curriculum, whether at high school, college or university. But increasingly, dealing with uncertainty from a mathematical and scientific perspective is also seen to be essential. For this reason, elements of probability theory and statistics give rise to the fourth overarching idea, *uncertainty*.

While this approach is somewhat different from the approach to content that would be taken from the perspective of mathematics instruction and the curricular strands typically taught in schools, nevertheless these overarching ideas encompass the full range of mathematical topics that students are expected to learn during their school mathematics studies.

The following list of overarching ideas, therefore, is used in PISA to meet the requirements of historical development, coverage of the domain and reflection of the major threads of school curriculum:

- space and shape
- change and relationships
- quantity
- uncertainty

With these four overarching ideas, mathematical content can be organised into a sufficient number of areas that ensure a spread of items across the curriculum while still maintaining a sufficiently broad focus to facilitate the presentation of problems based in real situations.

The basic conception of an overarching idea is an encompassing set of phenomena and concepts that make sense and can be encountered within and across a multitude of different situations. Each overarching idea can be perceived as a sort of general notion dealing with some generalised content dimension. This implies that neither can the overarching ideas, nor traditional mathematics content strands be sharply delineated in relation to one another. Rather, each idea represents a certain perspective or point of view and can be thought of as possessing a core, a centre of gravity, and somewhat blurred outskirts that allow for intersection with other overarching ideas. In principle, any overarching idea intersects any other overarching idea. The four overarching ideas are described in the following section.

Space and shape

Patterns are encountered everywhere: in spoken words, music, video, traffic, building constructions and art. Shapes can be regarded as patterns: of houses, office buildings, bridges, starfish, snowflakes, town plans, clover leaves, crystals or shadows. Geometric patterns can serve as relatively simple models of many kinds of phenomena, and their study is possible and desirable at all levels (Grünbaum, 1985).

It is important to have an understanding of the properties of objects and their relative positions. Students must be aware of how and why they see things and must learn to navigate through space and through constructions and shapes. This denotes an understanding of the relationship between shapes and images or visual representations, such as that between a real city and photographs and maps of the same city. It also includes an understanding of how three-dimensional objects can be represented in two dimensions, how shadows are formed and must be interpreted, and what perspective is and how it functions.

Shape has strong ties to traditional geometry, but goes far beyond it in content, meaning and method. Interaction with real shapes involves understanding the visual world and its description and encoding and decoding visual information. It also means interpreting visual information. In order to grasp the concept of shape, students should be able to discover the ways in which objects are similar and different, analyse the different components of an object, and recognise shapes in different dimensions and representations.

It is important to note that shapes can be more than just static entities. They can be transformed as entities, modified or sometimes visualised very elegantly using computer technology. Students should be able to see the patterns and regularities when shapes are changing. An example is shown in the following section in Figure 2.2.

The study of shapes and constructions requires looking for similarities and differences when analysing the components of form and recognising shapes in different representations and dimensions. The study of shapes is closely connected to the concept of *grasping space* (Freudenthal, 1973).

Examples requiring this kind of thinking are abundant and include the following: identifying and relating a photograph of a city to a map of that city and indicating from which point a picture was taken; the ability to draw a map; understanding why a nearby building looks bigger than a building that is further away; or understanding how the rails of a railway track appear to meet at the horizon. All these examples are relevant for students within this overarching idea.

As students live in a three-dimensional space, they should be familiar with views of objects from three orthogonal

aspects (for example, from the front, the side and above). They should be aware of the power and limitations of different representations of three-dimensional shapes, as indicated by the example provided in Figure 2.3. Students must not only understand the relative position of objects, but also how they can navigate through space and through constructions and shapes. An example is reading and interpreting a map and designing instructions on how to get from point A to point B using coordinates, common language or a picture.

Conceptual understanding of shapes also includes the ability to take a three-dimensional object and make a two-dimensional net of it, and vice-versa, even if the three-dimensional object is presented in two dimensions. An example of this is given in Figure 2.4.

Key aspects of *space and shape* are:

- recognising shapes and patterns in shapes;
- describing, encoding and decoding visual information;
- understanding dynamic changes to shapes;
- identifying similarities and differences;
- identifying relative positions;
- interpreting two-dimensional and three-dimensional representations and the relations between them;
- navigation through space.

Space and shape examples

Figure 2.2 offers a simple example of the need for flexibility in seeing shapes as they change. It is based on a cube that is being 'sectioned' (that is, plane cuts are made through the cube), and allows a variety of questions to be asked, such as:

What shapes can be produced by one plane cut through a cube?

How many faces, edges, or vertices will be produced when a cube is sectioned in this way?

Figure 2.2 ■ **A cube, with plane cuts in various places**

Three examples of the need for familiarity with representations of three-dimensional shapes follow. In the first example, the side and front views of an object constructed of cubes are given in Figure 2.3. The question is:

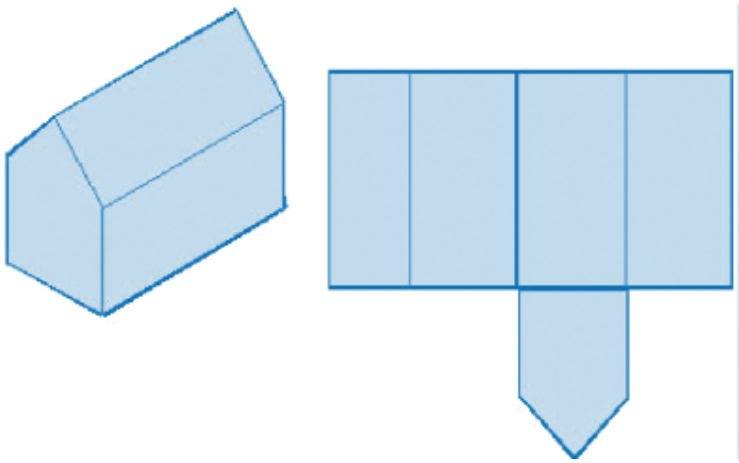
How many cubes have been used to make this object?

Figure 2.3 ■ **Side and front views of an object made from cubes**

It may come as a surprise to many – students and teachers alike – that the maximum number of cubes is 20 and the minimum is 6 (de Lange, 1995).

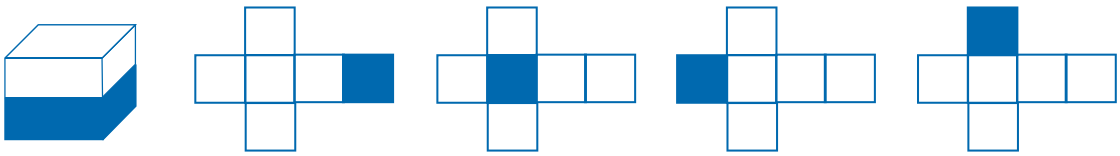
The next example shows a two-dimensional representation of a barn and an incomplete net of the barn. The problem is to complete the net of the barn.

Figure 2.4 ■ **Two-dimensional representation of a three-dimensional barn and its (incomplete) net**



A final example similar to the previous one is shown in Figure 2.5 (adapted from Hershkovitz *et al.*, 1996).

Figure 2.5 ■ **Cube with black bottom**



The lower half of the cube has been painted black. For each of the four nets, the bottom side is already black. Students could be asked to finish each net by shading the right squares.

Change and relationships

Every natural phenomenon is a manifestation of change, and the world around us displays a multitude of temporary and permanent relationships among phenomena. Examples include organisms changing as they grow; the cycle of seasons; the ebb and flow of tides; cycles of unemployment; weather changes; and stock exchange indices. Some of these processes of change involve and can be described or modelled by straightforward mathematical functions: linear, exponential, periodic or logistic, with any of these being either discrete or continuous. But many relationships fall into different categories, and data analysis is often essential in determining the kind of relationship that is present. Mathematical relationships often take the shape of equations or inequalities, but relations of a more general nature (*e.g.* equivalence, divisibility, inclusion, to mention but a few) may appear as well.

In order to be sensitive to the patterns of change, Stewart (1990) recommends:

- representing changes in a comprehensible form;
- understanding the fundamental types of change;
- recognising particular types of change when they occur;

- applying these techniques to the outside world;
- controlling a changing universe to the best advantage.

Change and relationships can be represented in a variety of ways including numerical (for example, in a table), symbolic, graphical, algebraic and geometrical. Translation between these representations is of key importance, as is the recognition of an understanding of fundamental relationships and types of change. Students should be aware of the concepts of linear growth (additive process), exponential growth (multiplicative process) and periodic growth, as well as logistic growth (at least informally as a special case of exponential growth).

Students should also see the relationships among these models – the key differences between linear and exponential processes, the fact that percentage growth is a form of exponential growth or how logistic growth occurs and why, either in continuous or discrete situations.

Changes occur in a system of interrelated objects or phenomena when the elements influence each other. In the examples mentioned in the summary, all phenomena change over time. But there are many real-life examples of matters in which objects are interrelated in a multitude of ways. For example:

> If the length of the string of a guitar is halved, the new tone is an octave higher than the original tone. The tone is therefore dependent on the string length.
>
> When we deposit money into a bank account, we know that the account balance will depend on the size, frequency and number of deposits and withdrawals, and the interest rates.

Relationships lead to dependency. Dependency concerns the fact that properties and changes of certain mathematical objects may depend on or influence properties and changes of other mathematical objects. Mathematical relationships often take the form of equations or inequalities, but relations of a more general nature may appear as well.

Change and relationships involves functional thinking. Functional thinking – that is, thinking in terms of and about relationships – is one of the most fundamental disciplinary aims of the teaching of mathematics (MAA, 1923). For 15-year-old students, this includes having a notion of rate of change, gradients and steepness (although not necessarily in a formal way), and dependence of one variable on another. Students should be able to make judgements about how fast processes are taking place in a relative way as well.

This overarching idea closely relates to aspects of other overarching ideas. The study of patterns in numbers can lead to intriguing relationships such as the study of Fibonacci numbers or the Golden Ratio. The Golden Ratio is a concept that plays a role in geometry as well, thus relating closely to the overarching idea of *space and shape*. Many more examples of *change and relationships* can be found in *space and shape*, such as with the growth of an area in relation to the growth of a perimeter or diameter. Euclidean geometry also lends itself to the study of relationships. A well-known example is the relationship between the three sides of a triangle. If the lengths of two sides are known, the third is not determined but the interval in which it lies is known; the interval's end points are the absolute value of the difference between the other two sides, and their sum, respectively. Several other similar relationships exist for the various elements of a triangle.

Uncertainty lends itself to various problems that can be viewed from the perspective of *change and relationships*. For example, if two fair dice have been rolled and one of them shows four, what is the chance that the sum exceeds seven? The answer (50%) relies on the dependency of the probability at issue on the set of favourable outcomes. The required probability is the proportion of all such outcomes compared with all possible outcomes, which is a functional dependency.

Change and relationships examples

MATHEMATICS EXAMPLE 5: SCHOOL EXCURSION

A school class wants to rent a coach for an excursion, and three companies are contacted for information about prices.

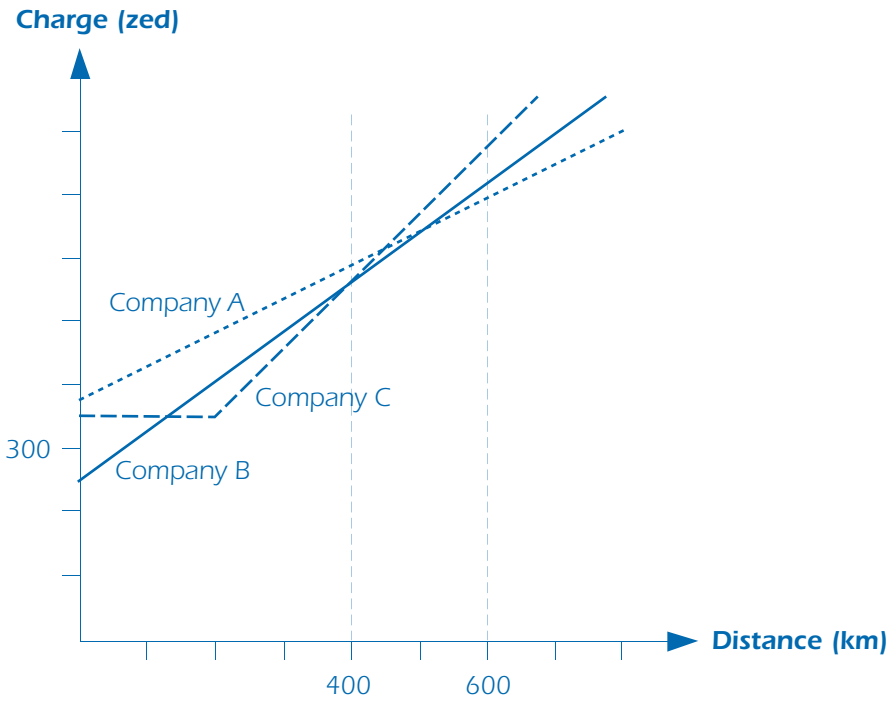
Company A charges an initial rate of 375 zed plus 0.5 zed per kilometre driven. Company B charges an initial rate of 250 zed plus 0.75 zed per kilometre driven. Company C charges a flat rate of 350 zed up to 200 kilometres, plus 1.02 zed per kilometre beyond 200 km.

Which company should the class choose, if the excursion involves a total travel distance of somewhere between 400 and 600 km?

Leaving aside the fictitious elements of the context, a problem like this could conceivably occur in the real world. Its solution requires the formulation and activation of several functional relationships, and equations and inequations. It can be dealt with by graphical as well as algebraic means, or combinations of both. The fact that the total travel distance in the excursion is not exactly known also introduces links to the *uncertainty* overarching idea, discussed in a later section.

A graphical representation of the problem is presented in Figure 2.6.

Figure 2.6 ■ **Excursion charges for three bus companies**



The following is another example of *change and relationships*.

MATHEMATICS EXAMPLE 6: CELL GROWTH

Doctors are monitoring the growth of cells. They are particularly interested in the day that the cell count will reach 60 000 because then they have to start an experiment. The table of results is:

Time (days)	4	6	8	10	12	14	16	18	20	22	24
Cells	597	893	1 339	1 995	2 976	4 434	6 606	9 878	14 719	21 956	32 763

Question 1: CELL GROWTH

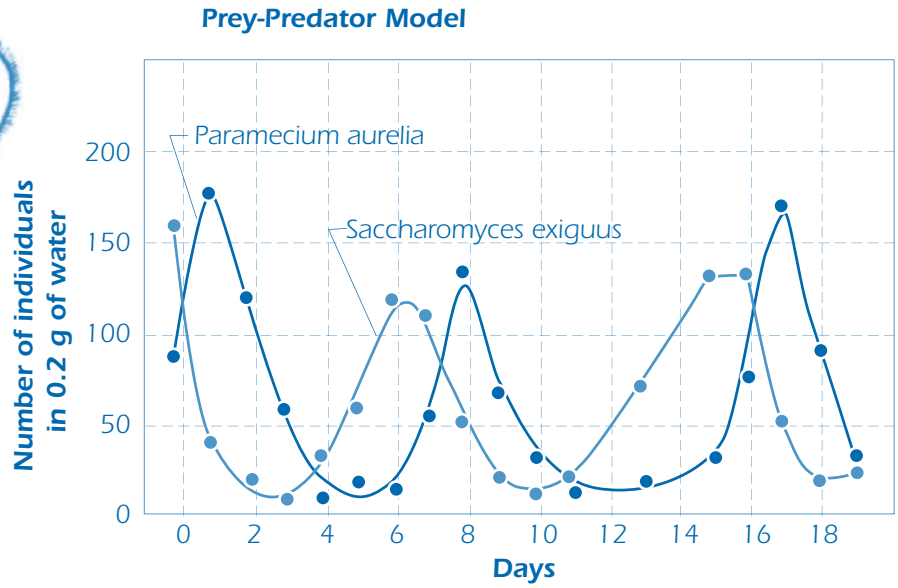
When will the number of cells reach 60 000?

MATHEMATICS EXAMPLE 7: PREY-PREDATOR

The following graph shows the growth of two living organisms: the Paramecium and Saccharomyces.:

Paramecium

Saccharomyces



One of the two animals (predator) eats the other one (prey). Looking at the graph, can you judge which one is the prey and which one the predator?

One property of prey-predator phenomena is expressed as: The rate of growth of predators is proportional to the number of available prey. Does this property hold for the above graphs?

Quantity

Important aspects of *quantity* include an understanding of relative size, recognition of numerical patterns, and use of numbers to represent quantities and quantifiable attributes of real-world objects (counts and measures). *Quantity* additionally deals with the processing and understanding of numbers that are represented to us in various ways.

An important aspect of dealing with *quantity* is quantitative reasoning. Essential components of quantitative reasoning are number sense, representing numbers in various ways, understanding the meaning of operations, having a feel for the magnitude of numbers, mathematically elegant computations, mental arithmetic and estimating.

Some of the most important and frequent uses of numbers in every-day life are seen when magnitudes are measured: length, area, volume, height, speed, mass, air pressure, money value are all quantified using measures.

Understanding the meaning of operations includes the ability to perform operations involving comparisons, ratios and percentages. Number sense addresses issues of relative size, different representations of numbers, equivalent form of numbers and using understanding of these things to describe attributes of the world.

Quantity also includes having a feeling for quantities and estimation. In order to be able to test numerical results for reasonableness, one needs a broad knowledge of quantities (measures) in the real world. Is the average speed of a car 5, 50 or 500 km/h? Is the population of the world 6 million, 600 million, 6 billion, or 60 billion? How tall is a tower? How wide is a river? The ability to make quick order-of-magnitude approximations is of particular importance, especially when viewed in light of the increasing use of electronic calculating tools. One needs to be able to see that 33 x 613 is something around 20 000. To achieve this skill one does not need extensive training in mental execution of traditional written algorithms, but a flexible and smart application of place value understanding and single-digit arithmetic (Fey, 1990).

By using number sense in an appropriate way, students can solve problems requiring direct, inverse and joint proportional reasoning. They are able to estimate rates of change and provide a rationale for the selection of data and level of precision required by operations and models they use. They can also examine alternative algorithms, showing why they work or in what cases they fail. They can develop models involving operations, and relationships between operations, for problems involving real-world data and numerical relations requiring operations and comparisons (Dossey, 1997).

In the overarching idea of *quantity*, there is a place for 'elegant' quantitative reasoning like that used by Gauss, as discussed in the following example. Creativity coupled with conceptual understanding should be valued at the level of schooling that includes 15-year-old students.

Quantity examples

MATHEMATICS EXAMPLE 8: GAUSS

Karl Friedrich Gauss' (1777–1855) teacher had asked the class to add together all the numbers from 1 to 100. Presumably the teacher's aim was to keep the students occupied for a time. But Gauss was an excellent quantitative reasoner and spotted a short-cut to the solution. His reasoning went like this:

> You write down the sum twice, once in ascending order, then in descending order, like this:
>
> 1 + 2 + 3 + ... + 98 + 99 + 100
>
> 100 + 99 + 98 +.....+ 3 + 2 + 1
>
> Now you add the two sums, column by column, to give:
>
> 101 + 101 +.....+ 101 + 101
>
> As there are exactly 100 copies of the number 101 in this sum its value is: 100 x 101 = 10 100.
>
> Since this product is twice the answer to the original sum, if you halve it, you obtain the answer: 5 050.

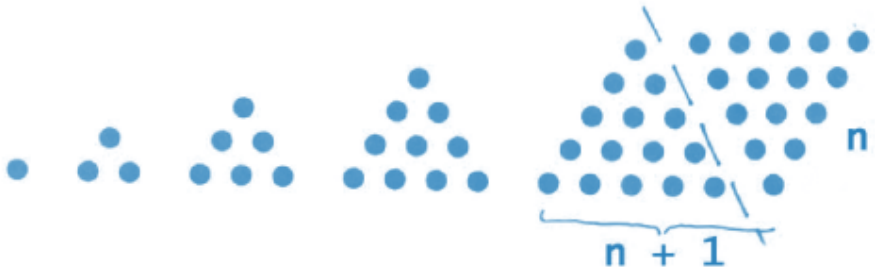
Triangular numbers

This example of quantitative thinking involving patterns of numbers can be taken a little further to demonstrate a link with a geometric representation of that pattern. The following formula gives the general situation for Gauss's problem:

$$1 + 2 + 3 + \cdots + n = n(n + 1)/2$$

This formula also captures a geometric pattern that is well known: numbers of the form n(n+1)/2 are called triangular numbers since they are precisely the numbers that are obtained when balls are arranged in an equilateral triangle.

Figure 2.7 ■ **The first five triangular numbers**



The first five triangular numbers 1, 3, 6, 10 and 15 are shown in Figure 2.7.

Proportional reasoning

It will be interesting to see how students in different countries solve problems that lend themselves to the use of a variety of strategies. Differences can be expected especially in the area of proportional reasoning. In some countries, one strategy per item is likely to be used, while in other countries more strategies will be used. Also, similarities in reasoning will appear in solving problems that do not look very similar. This is in line with recent research results from TIMSS data (Mitchell, J. *et al.*, 2000). The following three items illustrate this point about different strategies and the relationships among them:

1. Tonight you're giving a party. You want to buy 100 cans of soft drink. How many six-can packs are you going to buy?
2. A hang-glider with glide-ratio 1 to 22 starts from a sheer cliff at 120 metres. The pilot is aiming at a spot at a distance of 1 400 metres. Will she reach that spot (under conditions of no wind)?
3. A school wants to rent mini-vans (with seats for eight passengers) for going to a school camp and 98 students need transportation. How many vans does the school need?

The first problem could be seen as a division problem (100 ÷6=) that then leaves the student with an interpretation problem back to the context (what is the meaning of the remainder?). The second problem can be solved by proportional reasoning (for every metre height I can fly a distance of 22 metres, so starting from 120 metres…). The third problem will be solved by many as a division problem. All three problems, however, can be solved using the ratio table method:

Bottles :	1	10	5	15	2	17
	6	60	30	90	12	102

Flying :	1	100	20	120
	22	2200	440	2640

Buses :	1	10	2	13
	8	80	16	104

Identifying this similarity is a skill that belongs to mathematics: mathematically literate students do not need to look for the one available and appropriate tool or algorithm, but can choose from a wide array of strategies.

MATHEMATICS EXAMPLE 9: PERCENTS

Carl went to a store to buy a jacket with a normal price of 50 zed that was on sale for 20% off. In Zedland there is a 5% sales tax. The clerk first added the 5% tax to the price of the jacket and then took 20% off. Carl protested: he wanted the clerk to deduct the 20% discount first and then calculate the 5% tax.

Question 1: PERCENTS

Does it make any difference?

Problems involving this kind of quantitative thinking, and the need to carry out the resulting mental calculations, are encountered frequently when shopping. The ability to effectively handle such problems is fundamental to mathematics.

Uncertainty

Science and technology rarely deal with certainty. Indeed, scientific knowledge is seldom, if ever, absolute – and is even sometimes wrong – so some uncertainty always remains in even the most scientific predictions. Uncertainty is also present in daily life: uncertain election results, collapsing bridges, stock market crashes, unreliable weather forecasts, poor predictions for population growth, or economic models that don't align.

As an overarching idea, *uncertainty* suggests two related topics: data and chance. These phenomena are respectively the subject of mathematical study in statistics and probability. Relatively recent recommendations concerning school curricula are unanimous in suggesting that statistics and probability should occupy a much more prominent place than in the past (Committee of Inquiry into the Teaching of Mathematics in Schools, 1982; LOGSE, 1990; MSEB, 1990; NCTM, 1989; NCTM, 2000). Specific mathematical concepts and activities that are important in this area include collecting data, data analysis and display/visualisation, probability and inference.

The recommendations on the role of data, statistics and probability in school curricula emphasise data analysis. As a result, it is easy to view statistics in particular as a collection of specific skills. David S. Moore has pointed out what the overarching idea *uncertainty* really entails. The PISA definition will follow his ideas as presented in *On the Shoulders of Giants* (Steen, 1990) and F. James Rutherford's ideas as presented in *Why Numbers Count* (Steen, 1997).

Statistics brings something to mathematics education that is unique and important: reasoning from uncertain empirical data. This kind of statistical thinking should be part of the mental equipment of every intelligent citizen. The core elements are the:

- omnipresence of variation in processes;
- need for data about processes;
- design of data production with variation in mind;
- quantification of variation;
- explanation of variation.

Data are not merely numbers, but numbers in a context. Data are obtained by measurement and represented by a number. Thinking about measurement leads to a mature grasp of why some numbers are informative and others are irrelevant or nonsensical.

The design of sample surveys is a core topic in statistics. Data analysis emphasises understanding the specific data at hand, assuming they represent a larger population. The concept of simple random samples is essential for 15-year-old students to understand the issues related to uncertainty.

Phenomena have uncertain individual outcomes and the pattern of repeated outcomes is often random. The concept of probability in the present PISA study will generally be based to situations regarding chance devices like coins, number cubes and spinners, or not too complex real-world situations that can be analysed intuitively, or can feasibly be modelled with these devices.

Uncertainty also appears from sources like natural variation in students' heights, reading scores, incomes of a group of people, etc. A very important step, even for 15-year-old students, is to see the study of data and chance as a coherent whole. One such principle is the progression of ideas from simple data analysis to data production to probability to inference.

The important specific mathematical concepts and activities in this area are:

- producing data
- data analysis and data display/visualisation
- probability
- inference

Uncertainty examples

The following examples illustrate the *uncertainty* overarching idea.

MATHEMATICS EXAMPLE 10: AVERAGE AGE

If 40% of the population of a country are at least 60 years old, is it then possible for the average age to be 30?

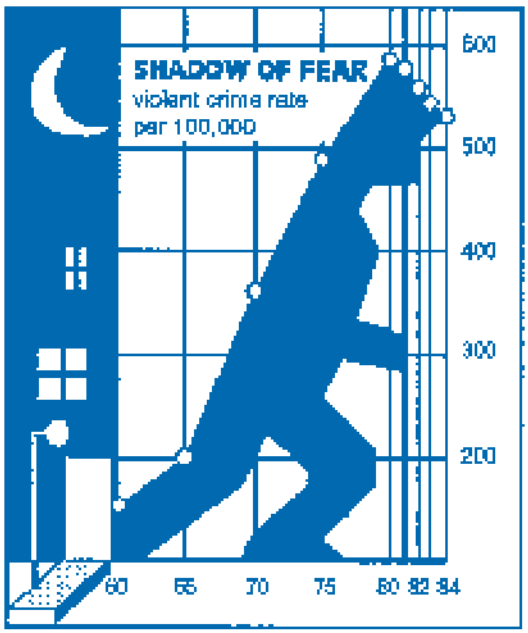
MATHEMATICS EXAMPLE 11: GROWING INCOMES?

Has the income of people in Zedland gone up or down in recent decades? The median money income per household fell: in 1970 it was 34 200 zed, in 1980 it was 30 500 zed and in 1990 31 200 zed. But the income per person increased: in 1970 13 500 zed, in 1980 13 850, and in 1990 15 777 zed.

A household consists of all people living together at the same address. Explain how it is possible for the household income to go down at he same time the per-person income has risen in Zedland.

MATHEMATICS EXAMPLE 12: RISING CRIMES

The following graph was taken from the weekly Zedland *News Magazine*:

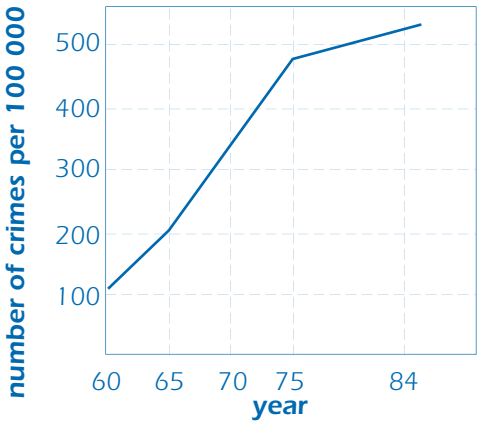


It shows the number of reported crimes per 100 000 inhabitants, starting with five-year intervals, then changing to one-year intervals.

Question 1: RISING CRIMES

How many reported crimes per 100 000 were there in 1960?

Manufacturers of alarm systems used the same data to produce the following graph:



Crime triples
STOP
the increase

▪ BUY ALARM SYSTEMS ▪

Question 2: RISING CRIMES

How did the designers come up with this graph and why?

The police were not too happy with the graph from the alarm systems manufacturers because the police want to show how successful crime fighting has been.

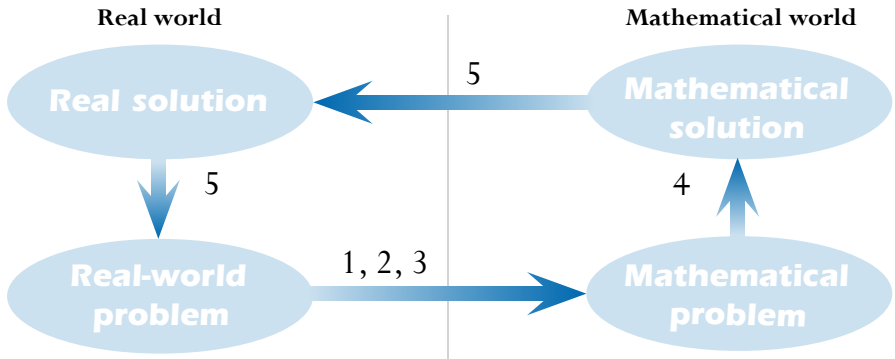
Design a graph to be used by the police to demonstrate that crime has decreased recently.

Mathematical processes

Mathematisation

PISA examines the ability of students to analyse, reason and communicate mathematical ideas effectively as they pose, formulate, solve and interpret mathematical problems in a variety of situations. Such problem solving requires students to use the mathematical processes, knowledge and skills they have acquired through schooling and life experiences. In PISA, the fundamental process that students use to solve real-life problems is referred to as mathematisation.

Figure 2.8 ■ **The mathematisation cycle**



The discussion above of the theoretical basis for the PISA mathematics framework outlines a five-step description of mathematisation. These steps are shown in Figure 2.8 and listed below:

1. Starting with a problem situated in reality.
2. Organising it according to mathematical concepts and identifying the relevant mathematics involved.
3. Gradually trimming away the reality through processes such as making assumptions, generalising and formalising. These processes promote the mathematical features of the situation and transform the real-world problem into a mathematical problem that faithfully represents the situation.
4. Solving the mathematical problem.
5. Making sense of the mathematical solution in terms of the real situation, including identifying the limitations of the solution.

Mathematisation first involves translating the problem from reality into mathematics. This process includes activities such as:

- Identifying the relevant mathematics with respect to a problem situated in reality.
- Representing the problem in a different way, including organising it according to mathematical concepts and making appropriate assumptions.
- Understanding the relationships between the language of the problem and the symbolic and formal language needed to understand it mathematically.
- Finding regularities, relations and patterns.
- Recognising aspects that are isomorphic with known problems.
- Translating the problem into mathematics *i.e. to* a mathematical model (de Lange, 1987).

As soon as a student has translated the problem into a mathematical form, the whole process can continue within mathematics. Students pose questions like: "Is there…?", "If so, how many?", "How do I find…?", using known mathematical skills and concepts. They attempt to work on their model of the problem situation, adjust it, establish regularities, identify connections and create a good mathematical argument. This part of the mathematisation process is generally called the deductive part of the modelling cycle

(Blum, 1996; Schupp, 1988). However, processes other than strictly deductive ones may play a part in this stage as well. This part of the mathematisation process includes:

- Using and switching between different representations.
- Using symbolic, formal and technical language and operations.
- Refining and adjusting mathematical models, combining and integrating models.
- Argumentation.
- Generalisation.

The last step or steps in solving a problem involve reflecting on the whole mathematisation process and the results. Here students must interpret the results with a critical attitude and validate the whole process. Such reflection takes place at all stages of the process, but it is especially important at the concluding stage. Aspects of this reflecting and validating process are:

- Understanding the extent and limits of mathematical concepts.
- Reflecting on mathematical arguments and explaining and justifying results.
- Communicating the process and solution.
- Critiquing the model and its limits.

This stage is indicated in two places in Figure 2.8 by the label 5 , where the mathematisation process passes from the mathematical solution to the real solution and is related back to the original real-world problem.

The cognitive mathematical competencies

The previous section focused on the major concepts and processes involved in mathematisation. An individual who is to engage successfully in mathematisation within a variety of situations, extra- and intra-mathematical contexts, and overarching ideas, needs to possess a number of mathematical competencies which, taken together, can be seen as constituting comprehensive mathematical competence. Each of these competencies can be possessed at different levels of mastery. Different parts of mathematisation draw differently upon these competencies, with regard to both the particular ones involved and the level of mastery required. PISA has decided to make use of eight characteristic cognitive mathematical competencies that rely, in their present form, on the work of Niss (1999) and his Danish colleagues. Similar formulations may be found in the work of many others (as indicated in Neubrand *et al.,* 2001). Some of the terms used, however, are used differently among different authors.

- *Thinking and reasoning*: this involves posing questions characteristic of mathematics ("Is there...?", "If so, how many?", "How do I find...?"); knowing the kinds of answers mathematics can offer to such questions; distinguishing between different kinds of statements (definitions, theorems, conjectures, hypotheses, examples, conditioned assertions); and understanding and handling the extent and limits of given mathematical concepts.
- *Argumentation*: this involves knowing what mathematical proofs are and how they differ from other kinds of mathematical reasoning; following and assessing chains of mathematical arguments of different types; possessing a feel for heuristics ("What can or cannot happen, and why?"); and creating and expressing mathematical arguments.
- *Communication*: this involves expressing oneself, in a variety of ways, on matters with a mathematical content, in oral as well as in written form, and understanding others' written or oral statements about such matters.
- *Modelling*: this involves structuring the field or situation to be modelled; translating reality into mathematical structures; interpreting mathematical models in terms of reality; working with a mathematical model; validating the model; reflecting, analysing and offering a critique of a model and its results; communicating about the model and its results (including the limitations of such results); and monitoring and controlling the modelling process.

- *Problem posing and solving*: this involves posing, formulating and defining different kinds of mathematical problems (for example "pure", "applied", "open ended" and "closed"), and solving different kinds of mathematical problems in a variety of ways.
- *Representation*: this involves decoding and encoding, translating, interpreting and distinguishing between different forms of representation of mathematical objects and situations; the interrelationships between the various representations; and choosing and switching between different forms of representation, according to situation and purpose.
- *Using symbolic, formal and technical language and operations*: this involves decoding and interpreting symbolic and formal language, and understanding its relationship to natural language; translating from natural language to symbolic/formal language; handling statements and expressions containing symbols and formulae; and using variables, solving equations and undertaking calculations.
- *Use of aids and tools*: this involves knowing about and being able to make use of various aids and tools (including information technology tools) that may assist mathematical activity and knowing about the limitations of such aids and tools.

PISA does not test these cognitive mathematical competencies individually. There is considerable overlap among them, and when using mathematics, it is usually necessary to draw simultaneously on many of them, so that any effort to assess individual ones is likely to result in artificial tasks and unnecessary compartmentalisation. The particular mathematical processes, knowledge and skills students are able to display vary considerably among individuals. This is partially because all learning occurs through experiences, "with individual knowledge construction occurring through the processes of interaction, negotiation, and collaboration (de Corte, Greer and Verschaffel, 1996). PISA assumes that much of students' mathematics is learned in schools and acknowledges that an understanding of the domain is acquired gradually. More formal and abstract ways of representing and reasoning emerge over time as a consequence of engagement in activities designed to help informal ideas evolve. Mathematical understanding is also acquired through experience involving interactions in a variety of social situations or contexts.

Some structure is needed in order to productively describe and report students' capabilities, as well as their strengths and weaknesses from an international perspective. One way of providing this in a comprehensible and manageable way is to describe clusters of cognitive mathematical competencies, based on the kinds of cognitive demands needed to solve different mathematical problems.

Competency clusters

PISA has chosen to describe the cognitive activities that these cognitive mathematical competencies encompass according to three clusters: the *reproduction* cluster, the *connections* cluster and the *reflection* cluster. In the following sections the three clusters are described and the ways in which the individual competencies are played out in each cluster are discussed.

The reproduction cluster

The mathematical competencies in this cluster involve the reproduction of practised knowledge. They include those mathematical processes, knowledge and skills most commonly targeted on standardised assessments and classroom tests. These are knowledge of facts and of common problem representations, recognition of equivalents, recollection of familiar mathematical objects and properties, performance of routine procedures, application of standard algorithms and technical skills, manipulation of expressions containing symbols and formulae in standard form, and carrying out computations.

- *Thinking and reasoning*: this involves posing the most basic forms of questions ("How many...?", "How much is...?") and understanding the corresponding kinds of answers ("so many...", "this much..."); distinguishing between definitions and assertions; understanding and handling mathematical concepts in the sorts of contexts in which they were first introduced or have subsequently been practised.
- *Argumentation*: this involves following and justifying standard quantitative processes, including computational processes, statements and results.

- *Communication*: this involves understanding and expressing oneself orally and in writing about simple mathematical matters, such as reproducing the names and the basic properties of familiar objects, citing computations and their results, usually not in more than one way.
- *Modelling*: this involves recognising, recollecting, activating and exploiting well-structured, familiar models; interpreting back and forth between such models (and their results) and reality; and elementary communication about model results.
- *Problem posing and solving*: this involves posing and formulating problems by recognising and reproducing practised standard pure and applied problems in closed form; and solving such problems by invoking and using standard approaches and procedures, typically in one way only.
- *Representation*: this involves decoding, encoding and interpreting familiar, practised standard representations of well known mathematical objects. Switching between representations is involved only when the switching itself is an established part of the representations implied.
- *Using symbolic, formal and technical language and operations*: this involves decoding and interpreting routine basic symbolic and formal language practised in well known contexts and situations; and handling simple statements and expressions containing symbols and formulae, including using variables, solving equations and undertaking calculations by routine procedures.
- *Use of aids and tools*: this involves knowing about and being able to use familiar aids and tools in contexts, situations and ways close to those in which their use was introduced and practised.

Assessment items measuring the *reproduction* cluster can be described with the following key descriptors: reproducing practised material and performing routine operations.

The following are examples of *reproduction* cluster items that could be used in the assessment:

MATHEMATICS EXAMPLE 13

Solve the equation $7x-3 = 13x+15$

MATHEMATICS EXAMPLE 14

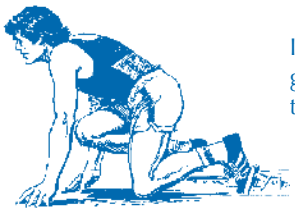
What is the average of 7, 12, 8, 14, 15, 9?

MATHEMATICS EXAMPLE 15

1000 zed is put in a savings account at a bank, with an interest rate of 4%. How many zed will there be in the account after one year?

REACTION TIME, is an example of a PISA item used in the 2003 Field Trial. EXPORTS was used in the 2003 main survey.

MATHEMATICS EXAMPLE 16: REACTION TIME



In a sprinting event, the reaction time is the time interval between the starter's gun firing and the athlete leaving the starting block. The final time includes both this reaction time, and the running time.

The following table gives the reaction time and the final time of 8 runners in a 100 metre sprint race.

Lane	Reaction time (sec)	Final time (sec)
1	0.147	10.09
2	0.136	9.99
3	0.197	9.87
4	0.180	Did not finish the race
5	0.210	10.17
6	0.216	10.04
7	0.174	10.08
8	0.193	10.13

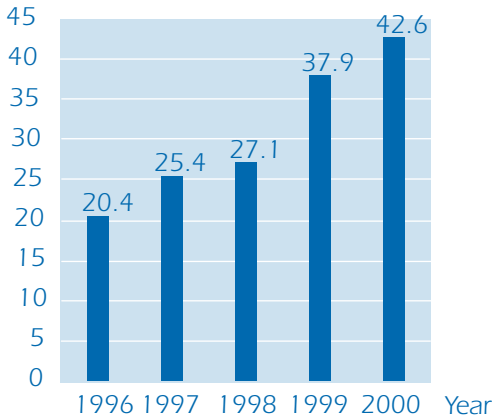
Question 1: REACTION TIME

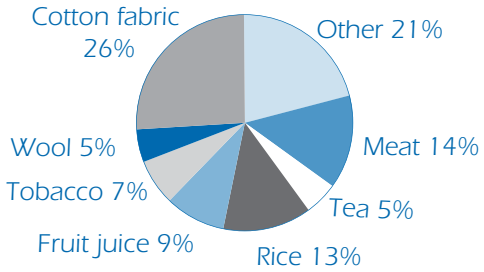
Identify the Gold, Silver and Bronze medallists from this race. Fill in the table below with the medallists' lane number, reaction time and final time.

Medal	Lane	Reaction time (sec)	Final time (sec)
GOLD			
SILVER			
BRONZE			

MATHEMATICS EXAMPLE 17: EXPORTS

The graphics show information about exports from Zedland, a country that uses zeds as its currency.





Question 1: EXPORTS

What was the value of fruit juice exported from Zedland in 2000?

A. 1.8 million zeds.

B. 2.3 million zeds.

C. 2.4 million zeds.

D. 3.4 million zeds.

E. 3.8 million zeds.

In order to clarify the boundary for items from the *reproduction* cluster, the *SAVINGS ACCOUNT* problem described in Example 3 provides an example that does not belong to the *reproduction* cluster. This problem takes most students beyond the simple application of a routine procedure and requires the application of a chain of reasoning and sequence of computational steps that are not characteristic of mathematical processes, knowledge and skills in the *reproduction* cluster.

The connections cluster

The *connections* cluster builds on the *reproduction* cluster by applying problem solving to situations that are not routine but still involve familiar or quasi-familiar settings. These mathematical processes knowledge and skills include the following:

- *Thinking and reasoning:* this involves posing questions ("How do I find...?", "Which mathematics is involved...?") and understanding the corresponding kinds of answers (provided by means of tables, graphs, algebra, figures, etc.); distinguishing between definitions and assertions and between different kinds of assertions; and understanding and handling mathematical concepts in contexts that are slightly different from those in which they were first introduced or have subsequently been practised.
- *Argumentation*: this involves simple mathematical reasoning without distinguishing between proofs and broader forms of argument and reasoning; following and assessing chains of mathematical arguments of different types; and possessing a feel for heuristics (*e.g.* What can or cannot happen, or be the case, and why?", "What do I know and what do I want to obtain?").
- *Communication*: this involves understanding and expressing oneself orally and in writing about mathematical matters ranging from reproducing the names and basic properties of familiar objects and explaining computations and their results (usually in more than one way), to explaining matters that include relationships. It also involves understanding others' written or oral statements about such matters.
- *Modelling*: this involves structuring the field or situation to be modelled; translating reality into mathematical structures in contexts that are not too complex but nevertheless different from what students are usually familiar with. It also involves interpreting back and forth between models (and their results) and reality, including aspects of communication about model results.
- *Problem posing and solving*: this involves posing and formulating problems beyond the reproduction of practised standard pure and applied problems in closed form and solving such problems by invoking and using standard approaches and procedures, as well as more independent problem-solving processes in which connections are made between different mathematical areas and modes of representation and communication (schemata, tables, graphs, words, pictures).
- *Representation*: this involves decoding, encoding and interpreting familiar and less familiar representations of mathematical objects; choosing and switching between different forms of representation of mathematical objects and situations; and translating and distinguishing between different forms of representation.
- *Using symbolic, formal and technical language and operations*: This involves decoding and interpreting basic symbolic and formal language in less well-known contexts and situations, and handling statements and expressions containing symbols and formulae, including using variables, solving equations and undertaking calculations using familiar procedures.
- *Use of aids and tools*: this involves knowing about and using familiar aids and tools in contexts, situations and ways that are different from those in which their use was introduced and practised.

Items associated with this cluster usually require some evidence of the integration and connection of material from the various overarching ideas, or from different mathematical curriculum strands, or the linking of different representations of a problem.

Assessment items measuring the *connections* cluster might be described with the following key descriptors: integrating, connecting and modest extension of practised material.

Examples of connections cluster items

One example of a *connections* cluster item was given in the SAVINGS ACCOUNT problem described in Example 3. Other examples of *connections* cluster items follow.

MATHEMATICS EXAMPLE 18: DISTANCE

Mary lives two kilometres from school, Martin five.

Question 1: DISTANCE

How far do Mary and Martin live from each other?

When this problem was originally presented to teachers, many of them rejected it on the grounds that it was too easy – one could easily see that the answer was three. Another group of teachers argued that it was not a good item because there was no answer – meaning there was not one single numerical answer. A third reaction was that it was not a good item because there were many possible answers since without further information, the most that could be concluded was that Mary and Martin live somewhere between three and seven kilometres from one another, and that was not desirable for an item. A small group thought it was an excellent item because one must understand the question, it is real problem solving because there is no strategy known to the student, and it is beautiful mathematics, although you have no clue how students will solve the problem. It is this last interpretation that associates the problem with the mathematical processes, knowledge and skills in the connections cluster.

MATHEMATICS EXAMPLE 19: THE OFFICE RENTING

The following two advertisements appeared in a daily newspaper in a country where the units of currency are zeds.

BUILDING A	BUILDING B
Office space available 58-95 square metres 475 zeds per month 100-120 square metres 800 zeds per month	Office space available 35-260 square metres 90 zeds per square metre per year

Question 1: THE OFFICE RENTING

If a company is interested in renting an office of 110 square metres in that country for a year, at which office building, A or B, should the company rent the office in order to get the lower price? Show your work. [© IEA/TIMSS]

MATHEMATICS EXAMPLE 20: THE PIZZA

A pizzeria serves two round pizzas of the same thickness in different sizes. The smaller one has a diameter of 30 cm and costs 30 zeds. The larger one has a diameter of 40 cm and costs 40 zeds. [© PRIM, Stockholm Institute of Education]

Question 1: THE PIZZA

Which pizza is better value for money? Show your reasoning.

In both of these problems, students are required to translate a real-life situation into mathematical language, to develop a mathematical model that enables them to make a suitable comparison, to check that the solution fits in with the initial question context and to communicate the result. These are all activities associated with the *connections* cluster.

The reflection cluster

The mathematical processes, knowledge and skills in this cluster include an element of reflectiveness on the part of the student about the processes needed or used to solve a problem. They relate to students' abilities to plan solution strategies and implement them in problem settings that contain more elements and may be more 'original' (or unfamiliar) than those in the *connections* cluster. In addition to the processes, knowledge and skills described for the *connections* cluster, the *reflection* cluster includes the following:

- *Thinking and reasoning*: this involves posing questions ("How do I find...?", "Which mathematics are involved...?", "What are the essential aspects of the problem or situation…?") and understanding the corresponding kinds of answers (provided by tables, graphs, algebra, figures, specification of key points, etc.); distinguishing between definitions, theorems, conjectures, hypotheses and assertions about special cases, and reflecting upon or actively articulating these distinctions; understanding and handling mathematical concepts in contexts that are new or complex; and understanding and handling the extent and limits of given mathematical concepts, and generalising results.
- *Argumentation*: this involves simple mathematical reasoning, including distinguishing between proving and proofs and broader forms of argument and reasoning; following, assessing and constructing chains of mathematical arguments of different types; and using heuristics (*e.g.* What can or cannot happen, or be the case, and why?", "What do I know, and what do I want to obtain?", "Which properties are essential?", "How are the objects related?").
- *Communication*: this involves understanding and expressing oneself orally and in writing about mathematical matters ranging from reproducing the names and basic properties of familiar objects, and explaining computations and their results (usually in more than one way), to explaining matters that include complex relationships, including logical relationships. It also involves understanding others' written or oral statements about such matters.
- *Modelling*: this involves structuring the field or situation to be modelled; translating reality into mathematical structures in contexts that may be complex or largely different from what students are usually familiar with; interpreting back and forth between models (and their results) and reality, including aspects of communication about model results: gathering information and data, monitoring the modelling process and validating the resulting model. It also includes reflecting through analysing, offering a critique, and engaging in more complex communication about models and modelling.
- *Problem posing and solving*: this involves posing and formulating problems well beyond the reproduction of practised standard pure and applied problems in closed form; solving such problems by invoking and using standard approaches and procedures, but also more original problem-solving processes in which connections are being made between different mathematical areas and modes of representation and communication (schemata, tables, graphs, words, pictures). It also involves reflecting on strategies and solutions.
- *Representation*: this involves decoding, encoding and interpreting familiar and less familiar representations of mathematical objects; choosing and switching between different forms of representation of mathematical objects and situations, and translating and distinguishing between different forms of representation. It further involves the creative combination of representations and the invention of non-standard ones.
- *Using symbolic, formal and technical language and operations*: this involves decoding and interpreting symbolic and formal language practised in unknown contexts and situations, and handling statements and expressions containing symbols and formulae, including using variables, solving equations and undertaking calculations. It also involves the ability to deal with complex statements and expressions and with unfamiliar symbolic or formal language, and to understand and to translate between such language and natural language.
- *Use of aids and tools*: this involves knowing about and using familiar or unfamiliar aids and tools in contexts, situations and ways that are quite different from those in which their use was introduced and practised. It also involves knowing about limitations of aids and tools.

Assessment items measuring the *reflection* cluster might be described with the following key descriptors: advanced reasoning, argumentation, abstraction, generalisation and modelling applied to new contexts.

Examples of reflection cluster items

MATHEMATICS EXAMPLE 21: STUDENT HEIGHTS

In a mathematics class one day, the heights of all students were measured. The average height of boys was 160 cm, and the average height of girls was 150 cm. Alena was the tallest – her height was 180 cm. Zdenek was the shortest – his height was 130 cm.

Two students were absent from class that day, but they were in class the next day. Their heights were measured, and the averages were recalculated. Amazingly, the average height of the girls and the average height of the boys did not change.

Question 1: STUDENT HEIGHTS

Which of the following conclusions can be drawn from this information?

Circle 'Yes' or 'No' for each conclusion.

Conclusion	Can this conclusion be drawn?
Both students are girls.	Yes / No
One of the students is a boy and the other is a girl.	Yes / No
Both students have the same height.	Yes / No
The average height of all students did not change.	Yes / No
Zdenek is still the shortest.	Yes / No

This problem is quite complicated in several ways. It requires very precise reading, as superficial reading will likely lead to misinterpretation. Norris and Phillips (2003) have argued that reading literacy is fundamental for science literacy. In a similar way, mathematical literacy also depends to some degree on reading skills. The item above demonstrates the importance of the receptive aspect of the communication competency, which is demanded strongly in this case. It also demonstrates how this aspect of *mathematical literacy* intersects with other types of literacy, specifically *reading literacy*. Furthermore, the wording of the problem makes it difficult to locate the crucial mathematical information. The intersection of other domains with the PISA definition and assessment of mathematics cannot be avoided; however, at the core of each assessment task there should be aspects that relate unambiguously to mathematical knowledge and skills. In this case, interpreting written information that contains mathematical data, and converting this information to a useful mathematical formulation are key mathematical challenges to be negotiated before a solution can be found.

The situation varies within the *class* and over *time*. The entity *class* is used while discussing the average for boys and for girls independently, but subsequently it is stated that Alena is the tallest (girl or student) and Zdenek the shortest (boy or student). If the students do not read carefully they will miss the fact that Alena is a girl and Zdenek a boy.

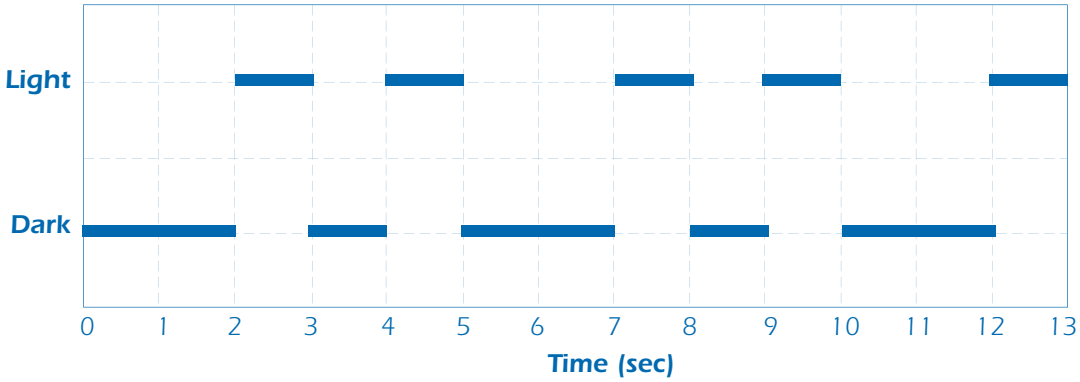
One obvious difficulty is the fact that the students have to combine the information from the first part of the stimulus (about the different heights) with the second part where the information about two missing students is presented. Here variation over *time* is seen: there are two students who were not present in the original setting, but have to be taken into account the next moment in time, so the entity class changes. However, the student solving the problem does not know whether the missing students are boys, girls or one of each. In addition, there is not one problem to solve, but five.

Furthermore, to be able to answer correctly the students need to understand mathematically the statistical concepts involved. The problem involves the ability to pose questions ("How do I know…?", "How do I find…?", "What are the possibilities…?" and "What happens if I…?") and the ability to understand and handle the concept of an average in texts that are complex, although the context is familiar.

From this description it is clear that this item is not only challenging for students (as shown by the PISA results) but also clearly belongs to the reflection cluster.

MATHEMATICS EXAMPLE 22: LIGHTHOUSE

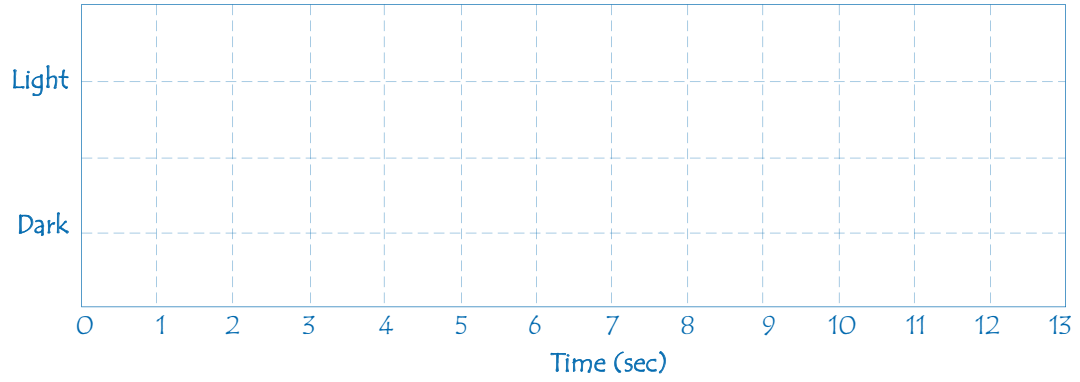
Lighthouses are towers with a light beacon on top. Lighthouses assist sea ships in finding their way at night when they are sailing close to the shore.
A lighthouse beacon sends out light flashes with a regular fixed pattern. Every lighthouse has its own pattern.
In the diagram below you see the pattern of a certain lighthouse. The light flashes alternate with dark periods.



It is a regular pattern. After some time the pattern repeats itself. The time taken by one complete cycle of a pattern, before it starts to repeat, is called the period. When you find the period of a pattern, it is easy to extend the diagram for the next seconds or minutes or even hours.

Question 1: LIGHTHOUSE

In the diagram below, make a graph of a possible pattern of light flashes of a lighthouse that sends out light flashes for 30 seconds per minute. The period of this pattern must be equal to 6 seconds.



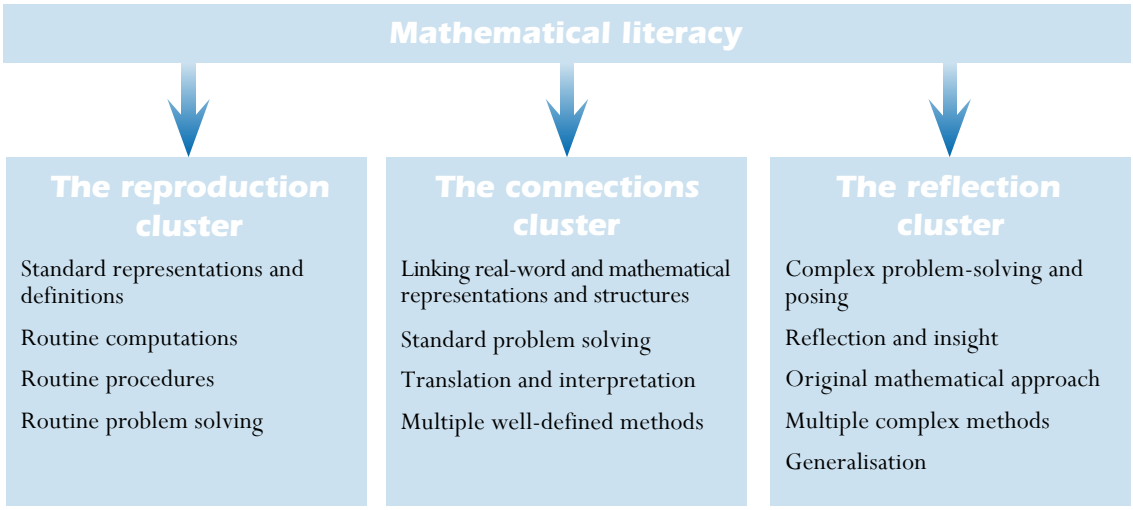
In this example, the students must first understand the introduction in the sense that this kind of graphs is most likely unknown to them, as is the idea of periodicity. In addition, the question posed is of a very open nature: the students are asked to design a possible pattern of light flashes. Many students do not encounter this kind of constructive question at school. However, this constructive aspect is an essential component of being mathematically literate: using mathematical competencies not only in a passive or derived way, but in constructing an answer. Solving the problem demands satisfying two conditions: equal amounts of time light and dark ("30 seconds per minute"), and a period of six seconds. This combination makes it essential for the students to engage with periodicity at the conceptual level – this involves the *reflection* cluster.

In this particular example, the context could be said to favour students living close to an ocean. It should be pointed out, however, that the PISA assessment of mathematics requires the capacity to use mathematics in contexts different from the local one. This ability to transfer is an essential competency. While certain students can be in a somewhat favourable position in certain contexts, and others in other contexts, the item by country analysis gives no indication that this is the case: landlocked countries did not perform differently from countries bordering on oceans.

Classification of items by competency cluster

Figure 2.9 summarises the distinctions between the clusters.

Figure 2.9 ■ **Diagram representing the competency clusters**



It is possible to use the descriptions outlined previously to classify mathematics items and thereby to assign them to one of the competency clusters. One way to do this is to analyse the demands of the item, then to rate each of the eight cognitive mathematical competencies for that item, according to which of the three clusters provide the most fitting description of item demands in relation to that competency. If any of the competencies were rated as fitting the description for the *reflection* cluster, then the item would be assigned to the *reflection* cluster. If not, but one or more of the competencies were rated as fitting the description for the *connections* cluster, then the item would be assigned to that cluster. Otherwise, the item would be assigned to the *reproduction* cluster, since all cognitive mathematical competencies would have been rated as fitting the descriptions for that cluster.

ASSESSING MATHEMATICS IN PISA

Task characteristics

This section considers, in more detail, features of the assessment tasks that are used to assess students. The nature of the tasks and the item format types are described below.

The nature of PISA mathematics tasks

PISA is an international survey of the knowledge and skills of 15-year-old students. All test items used should be suitable for the population of 15-year-old students in OECD countries.

Trained markers have access to items including some stimulus material or information, an introduction, the actual question and the required solution. In addition, for items with responses that cannot be automatically coded, a detailed coding scheme is developed to enable trained markers across the range of participating countries to code the student responses in a consistent and reliable way.

In an earlier section of this framework, the situations to be used for PISA mathematics items were discussed in some detail. For PISA, each item is set in one of four situation types: personal, educational/occupational, public and scientific. The items selected for the PISA mathematics instruments represent a spread across these situation types.

In addition, item contexts that can be regarded as authentic are preferred. That is, PISA values most highly the tasks that could be encountered in real-world situations and have a context that demands the use of mathematics to solve the problem in an authentic manner. Problems with extra-mathematical contexts that influence the solution and its interpretation are preferred as vehicles for assessing mathematical processes, knowledge and skills.

The selection of mathematics test items aims to ensure that the four overarching ideas are well represented. This framework requires the same of its mathematics test items. Items should relate predominantly to the overarching ideas (the phenomenological problem categories) described in the framework. Additionally, they should embody one or more of the mathematical processes that are described in the framework, and should be identified predominantly with one of the competency clusters.

The level of reading required to successfully engage with an item is considered very carefully when items are developed and selected for inclusion in the PISA test instrument. The wording of items is as simple and direct as possible. Care is also taken to avoid question contexts that would create a cultural bias.

Items selected for inclusion in the PISA test instruments represent a broad range of difficulties, to match the expected wide ability range of students participating in the PISA assessment. In addition, the major classifications of the framework (particularly competency clusters and overarching ideas) should, as much as possible, be represented by items of a wide range of difficulties. Item difficulties are established in an extensive field trial of test items prior to item selection for the main PISA survey.

Item types

When assessment instruments are devised, the impact of the item format type on student performance, and hence on the definition of the construct that is being assessed, must be carefully considered. This issue is particularly pertinent in a project such as PISA, where the large-scale cross-national context for testing puts serious constraints on the range of feasible item format types.

The PISA mathematics assessment employs a combination of items with open constructed-response types, closed constructed-response types and multiple-choice types. About equal numbers of each of these item format types are used in constructing the test instruments.

Based on experience in developing and using test items for PISA 2000, the multiple-choice type is generally regarded as most suitable for assessing items that would be associated with the *reproduction* and *connections* clusters. For an example of this item type, see Example 23, which shows an item that would be associated with the *connections* cluster and with a limited number of defined response options. To solve this problem, students

must translate the problem into mathematical terms, devise a model to represent the periodic nature of the context described, and extend the pattern to match the result with one of the given options.

MATHEMATICS EXAMPLE 23: SEAL

A seal has to breathe even if it is asleep. Martin observed a seal for one hour. At the start of his observation the seal dived to the bottom of the sea and started to sleep. In 8 minutes it slowly floated to the surface and took a breath.

In 3 minutes it was back at the bottom of the sea again and the whole process started over in a very regular way.

Question 1: SEAL

After one hour the seal was:

A. At the bottom

B. On its way up

C. Breathing

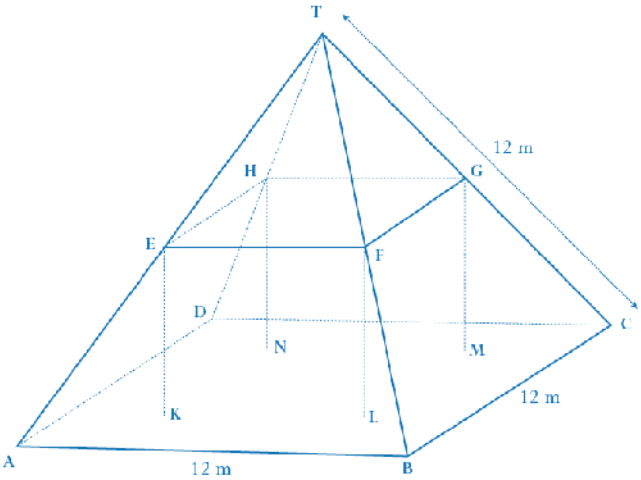
D. On its way down

Other format types are often preferred for some of the higher-order goals and more complex processes. Closed constructed-response items can pose similar questions to multiple-choice items, but students are asked to produce a response that can be easily judged as either correct or incorrect. For items in this type, guessing is not likely to be a concern, and the provision of distractors (which influence the construct that is being assessed) is not necessary. For example, the problem in Example 24 has one correct answer and many possible incorrect answers.

MATHEMATICS EXAMPLE 24: FARMS

Here you see a photograph of a farmhouse with a roof in the shape of a pyramid.

Below is a student's mathematical model of the farmhouse roof with measurements added.



The attic floor, ABCD in the model, is a square. The beams that support the roof are the edges of a block (rectangular prism) EFGHKLMN. E is the middle of AT, F is the middle of BT, G is the middle of CT and H is the middle of DT. All the edges of the pyramid in the model have length 12 m.

Question 1: FARMS

Calculate the area of the attic floor ABCD.

The area of the attic floor ABCD = _____ m^2

Open constructed-response items require a more extended response from the student, and the process of producing a response frequently involves higher-order cognitive activities. Often such items not only ask the student to produce a response, but also require the student to show their steps taken or explain how the answer was reached. The key feature of open constructed-response items is that students are allowed to demonstrate their abilities by providing solutions at a range of levels of mathematical complexity.

Example 25 was not used in any PISA assessment, it exemplifies the kinds of features that are present in open constructed-response items.

MATHEMATICS EXAMPLE 25: INDONESIA

Indonesia lies between Malaysia and Australia. Some data of the population of Indonesia and its distribution over the islands is shown in the following table:

Region	Surface area (km)	Percentage of total area	Population in 1980 (millions)	Percentage of total population
Java/Madura	132 187	6.95	91 281	61.87
Sumatra	473 606	24.86	27 981	18.99
Kalimantan (Borneo)	539 460	28.32	6 721	4.56
Sulawesi (Celebes)	189 216	9.93	10 377	7.04
Bali	5 561	0.30	2 470	1.68
Irian Jaya	421 981	22.16	1 145	5.02
TOTAL	1 905 569	100.00	147 384	100.00

One of the main challenges for Indonesia is the uneven distribution of the population over the islands. From the table we can see that Java, which has less than 7% of the total area, has almost 62% of the population.

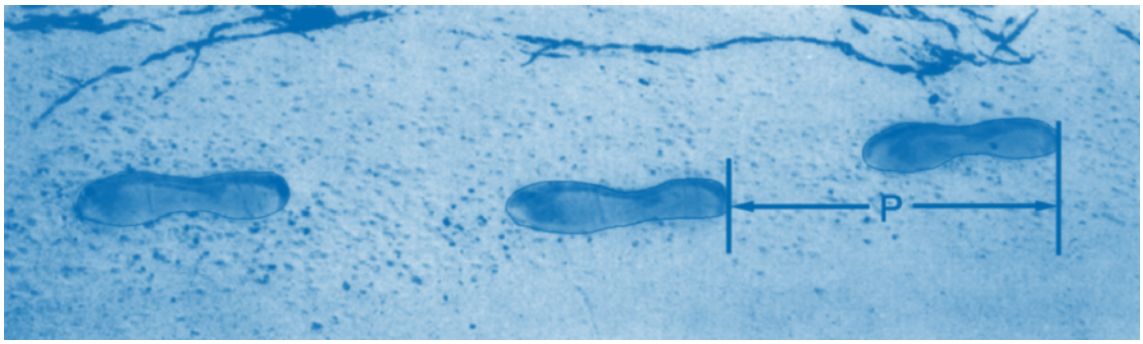
Source: de Lange and Verhage (1992). Used with permission.

Question 1: INDONESIA

Design a graph (or graphs) that shows the uneven distribution of the Indonesian population.

The following item is an example of an open constructed-response item that was used in PISA 2003:

MATHEMATICS EXAMPLE 26: WALKING



The picture shows the footprints of a man walking. The pacelength P is the distance between the rear of two consecutive footprints.

For men, the formula, $\frac{n}{P} = 140$, gives an approximate relationship between n and P where,

n = number of steps per minute, and

P = pace length in metres.

Question 1: WALKING

Bernard knows his pacelength is 0.80 metres. The formula applies to Bernard's walking.

Calculate Bernard's walking speed in metres per minute and in kilometres per hour. Show your working out.

About one-third of the mathematics items for PISA are open constructed-response items. The responses to these items require coding by trained individuals who implement a coding rubric that may require an element of professional judgement. Because of the potential for disagreement between coders of responses to these items, PISA implements coder reliability studies to monitor the extent of disagreement. Experience in these types of studies shows that clear coding rubrics can be developed and reliable scores can be obtained.

PISA makes some use of a unit format in which several items are linked to common stimulus material. Tasks of this format give students the opportunity to become involved with a context or problem by asking a series of questions of increasing complexity. The first few questions are typically multiple-choice or closed constructed-response items, while subsequent ones are typically open constructed-response items. This format can be used to assess each of the three clusters.

One reason for the use of common stimulus task formats is that they allow realistic tasks to be devised and the complexity of real-life situations to be reflected in them. Another reason relates to the efficient use of testing time, cutting down on the time required for a student to understand the problem. The need to make each scored point independent of others within a task is recognised and taken into account in the design of PISA tasks and the response coding and scoring rubrics. The importance of minimising bias that may result from using fewer situations is also recognised.

Assessment structure

In PISA 2003, when mathematics was the major PISA assessment domain, the test instruments contained a total of 210 minutes of testing time. The selected test items were arranged in seven clusters of items, with each item cluster representing 30 minutes of testing time, and the item clusters were placed in test booklets according to

a rotated test design. For the 2006 test cycle, when science was the major PISA assessment domain, less time was devoted to testing of mathematics, but the item clusters allocated to mathematics were constructed and rotated in a similar way. Similar arrangements apply to the mathematics test material for the PISA 2009 survey. In addition for 2009, clusters have been selected intact from those used in the 2006 survey to minimise any changed measurement effects arising from item placement factors.

The total testing time for mathematics is distributed as evenly as possible across the four overarching ideas (*space and shape, change and relationships, quantity* and *uncertainty*) and the four situations described in the framework (*personal, educational/occupational, public* and *scientific*). The proportion of items reflecting the three clusters (reproduction, connections and reflection) is about 1:2:1, respectively. Multiple-choice response types, closed constructed-response types, and open constructed-response types each represent about one-third of the items.

Aids and tools

PISA policy allows students to use calculators and other tools as they are normally used in school.

This represents the most authentic assessment of what students can achieve, and provides the most informative comparison of the performance of education systems. A system's choice to allow students to access and use calculators is no different, in principle, from other instructional policy decisions that are made by systems and are not controlled for by PISA.

Students who are used to having a calculator available to assist them in answering questions would be disadvantaged if this resource were taken away.

REPORTING PROFICIENCY IN MATHEMATICS

To summarise data from responses to the PISA test instruments, a six-level described performance scale was created (Masters and Forster, 1996; Masters, Adams, and Wilson, 1999). Statistically created, the scale uses an item response modelling approach to scale ordered outcome data. The overall scale is used to describe the nature of performance by classifying the student performances of different countries in terms of the five described performance levels and thus providing a frame of reference for international comparisons.

For the reporting of results from PISA 2003 when mathematics was the major domain, consideration was given to the development of a number of separate reporting scales. Such subscales could most obviously be based on the three clusters or the four overarching ideas. Decisions about the development of separate reporting scales were made on a variety of grounds, including psychometric considerations, following analysis of the data generated by the PISA assessments. To facilitate these possibilities, it was necessary to ensure that sufficient items were selected for inclusion in the PISA test instrument from each potential reporting category. Moreover, items within each such category needed to have a suitably wide range of difficulties. The balance of items across these categories has been broadly maintained in subsequent PISA administrations, but student outcomes have not been reported according to the content-based subscales for mathematics when it was a minor domain, such as in 2006 and 2009.

The competency clusters described earlier in this framework reflect conceptual categories of broadly increasing cognitive demand and complexity, but do not strictly reflect a hierarchy of student performances based on item difficulty. Conceptual complexity is only one component of item difficulty that influences levels of performance. Others include familiarity, recent opportunity to learn and practice, etc. Thus, a multiple-choice item involving the *reproduction* cluster (for example, "Which of the following is a rectangular parallelepiped?" followed by pictures of a ball, a can, a box, and a square) may be very easy for students who have been taught the meaning of these terms, but very difficult for others because of their lack of familiarity with the terminology used. While it is possible to imagine relatively difficult *reproduction* cluster items and relatively easy *reflection* cluster items, one would expect a broadly positive relationship between competency clusters and item difficulty.

Factors that underpin increasing levels of item difficulty and mathematical proficiency include the following:

- *The kind and degree of interpretation and reflection required*: this includes the nature of demands arising from the problem context; the extent to which the mathematical demands of the problem are apparent or to which students must impose their own mathematical construction on the problem, and the extent to which insight, complex reasoning and generalisation are required.
- *The kind of representation skills required*: these include problems where only one mode of representation is used, as well as problems where students have to switch between different modes of representation or search for appropriate modes of representation themselves.
- *The kind and level of mathematical skill required*: these include single-step problems requiring students to reproduce basic mathematical facts and perform simple computation processes, multi-step problems involving more advanced mathematical knowledge, complex decision-making, information processing, and problem solving and modelling skills.
- *The kind and degree of mathematical argumentation required*: these include problems where no arguing is necessary, problems where students may apply well-known arguments, and problems where students have to create mathematical arguments, understand other people's argumentation or judge the correctness of given arguments or proofs.

At the lowest described proficiency level, students typically carry out single-step processes that involve the recognition of familiar contexts and mathematically well-formulated problems, reproducing well-known mathematical facts or processes, and applying simple computational skills.

At higher proficiency levels, students typically carry out more complex tasks involving more than a single processing step. They also combine different pieces of information or interpret different representations of mathematical concepts or information, recognising which elements are relevant and important and how they relate to one another. They typically work with given mathematical models or formulations, frequently in algebraic form, to identify solutions, or they carry out a small sequence of processing or calculation steps to produce a solution.

At the highest proficiency level, students take a more creative and active role in their approach to mathematical problems. They typically interpret more complex information and negotiate a number of processing steps. They produce a formulation of a problem and often develop a suitable model that facilitates its solution. Students at this level can typically identify and apply relevant tools and knowledge in an unfamiliar problem context. They likewise demonstrate insight in identifying a suitable solution strategy, and display other higher-order cognitive processes such as generalisation, reasoning and argumentation to explain or communicate results.

In Figure 2.10 the six described levels of mathematical proficiency developed for the PISA 2003 survey administration are presented, together with their associated scores on the PISA mathematics scale. The same descriptions were used in reporting the 2006 survey outcomes, and will also be used to report the PISA 2009 outcomes.

Figure 2.10 ■ **Summary descriptions of the six proficiency levels in mathematics**

	Lower score limit	What students can typically do at each level
Level 6	669.3	At Level 6 students can conceptualise, generalise, and utilise information based on their investigations and modelling of complex problem situations. They can link different information sources and representations and flexibly translate among them. Students at this level are capable of advanced mathematical thinking and reasoning. These students can apply this insight and understandings along with a mastery of symbolic and formal mathematical operations and relationships to develop new approaches and strategies for attacking novel situations. Students at this level can formulate and precisely communicate their actions and reflections regarding their findings, interpretations, arguments, and the appropriateness of these to the original situations.
Level 5	607.0	At Level 5 students can develop and work with models for complex situations, identifying constraints and specifying assumptions. They can select, compare, and evaluate appropriate problem solving strategies for dealing with complex problems related to these models. Students at this level can work strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, symbolic and formal characterisations, and insight pertaining to these situations. They can reflect on their actions and formulate and communicate their interpretations and reasoning.
Level 4	544.7	At Level 4 students can work effectively with explicit models for complex concrete situations that may involve constraints or call for making assumptions. They can select and integrate different representations, including symbolic ones, linking them directly to aspects of real-world situations. Students at this level can utilise well-developed skills and reason flexibly, with some insight, in these contexts. They can construct and communicate explanations and arguments based on their interpretations, arguments, and actions.
Level 3	482.4	At Level 3 students can execute clearly described procedures, including those that require sequential decisions. They can select and apply simple problem solving strategies. Students at this level can interpret and use representations based on different information sources and reason directly from them. They can develop short communications reporting their interpretations, results and reasoning.
Level 2	420.1	At Level 2 students can interpret and recognise situations in contexts that require no more than direct inference. They can extract relevant information from a single source and make use of a single representational mode. Students at this level can employ basic algorithms, formulae, procedures, or conventions. They are capable of direct reasoning and making literal interpretations of the results.
Level 1	357.8	At Level 1 students can answer questions involving familiar contexts where all relevant information is present and the questions are clearly defined. They are able to identify information and to carry out routine procedures according to direct instructions in explicit situations. They can perform actions that are obvious and follow immediately from the given stimuli.

CONCLUSION

The aim of the PISA study, with regard to mathematics, is to develop indicators that show, from the perspective of the use of mathematics, how effectively countries have prepared their 15-year-old students to become active, reflective and intelligent citizens. To achieve this, PISA has developed assessments that focus on determining the extent to which students can use what they have learned. PISA emphasises mathematical processes, knowledge and understanding to solve problems that arise out of day-to-day experience, and provides a variety of problems with varying degrees of built-in guidance and structure, while simultaneously pushing towards authentic problems where students must do the thinking themselves.

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3

PISA 2009 Science Framework

This chapter presents the theory underlying the PISA 2009 science assessment. It begins with a definition of scientific literacy, outlines the organisation of science in PISA and sets the context for the test questions. The chapter describes the knowledge and skills at the heart of the assessment: identifying scientific issues, explaining phenomena scientifically and using scientific evidence. It then describes how knowledge and attitudes are also encompassed in the PISA definition of scientific literacy. Test questions are given as examples throughout this chapter to illustrate the classification, format and structure of the PISA science assessment.

INTRODUCTION

This framework describes and illustrates the definition of *scientific literacy* as used in PISA and sets the context for the items. Science is a minor domain in PISA 2009. The definition of the domain is unchanged since PISA 2006 when for the first time it was the major domain assessed (OECD, 2006; Bybee & McCrae, 2009), though there are some changes in terminology, which have been brought about by an attempt to better align the language used in PISA with the language used in the OECD's DeSeCo initiative (OECD, 2003).

In this framework, the term *science literacy* denotes an overarching competency comprising a set of three specific scientific competencies. A competency is more than just knowledge and skills (OECD, 2003). It includes the capacity to mobilise cognitive and non-cognitive resources in any given context. When discussing the cognitive dimensions of the specific scientific competencies, as is pertinent to the PISA science assessment in the current cycle, reference is made to the relevant *scientific knowledge and skills* demonstrated by students. However, the sub-scales of the PISA science scale as established in PISA 2006 (OECD, 2006) are still referred to as *scientific competencies*.

In keeping with its status as a minor domain in this cycle, the student questionnaire will not include items asking about students' general attitudes towards science; nor will the main assessment instrument include questions on attitudes alongside the testing of cognitive abilities and knowledge, as was the case in PISA 2006. In this revised version of the science framework for PISA 2009, the section describing the PISA science assessment has been revised to reflect these changes, the discussion on reporting scales has been updated, and released examples from PISA 2006 have been included to illustrate the framework.

An understanding of science and technology is central to a young person's preparedness for life in modern society. It enables an individual to participate fully in a society in which science and technology play a significant role. This understanding also empowers individuals to participate appropriately in the determination of public policy where issues of science and technology impact on their lives. An understanding of science and technology contributes significantly to the personal, social, professional and cultural lives of everyone.

A large proportion of the situations, problems and issues encountered by individuals in their daily lives require some understanding of science and technology before they can be fully understood or addressed. Science and technology related issues confront individuals at personal, community, national and even global levels. Therefore, national leaders should be encouraged to ask about the degree to which all individuals in their respective countries are prepared to deal with these issues. A critical aspect of this is how young people respond to scientific questions when they emerge from school. An assessment at age 15 provides an early indication of how students may respond later in life to the diverse array of situations that involve science and technology.

As the basis for an international assessment of 15-year-old students, it seems reasonable, therefore, to ask: What is it important for citizens to know, value, and be able to do in situations involving science and technology?" Answering this question establishes the basis for an assessment of students with regards to how their knowledge, values and abilities today relate to what they will need in the future. Central to the answer are the competencies that lie at the heart of the PISA science assessment. These ask how well students:

- identify scientific issues
- explain phenomena scientifically
- use scientific evidence

These competencies require students to demonstrate, on the one hand, knowledge and cognitive abilities, and on the other, attitudes, values and motivations, as they meet and respond to science-related issues.

The issue of identifying what citizens should know, value and be able to do in situations involving science and technology, seems simple and direct. However, doing so raises questions about scientific understanding and does not imply mastery of all scientific knowledge. This framework is guided by reference to what citizens require. As citizens, what knowledge is most appropriate? An answer to this question certainly includes basic concepts of the science disciplines, but that knowledge must be used in contexts that individuals encounter in life. In addition, people often encounter situations that require some understanding of science as a process that produces knowledge and proposes explanations about the natural world.[1] Further, they should be aware of the complementary relationships between science and technology, and how science-based technologies pervade and influence the nature of modern life.

What is important for citizens to value about science and technology? An answer should include the role and contributions to society of science and of science-based technology, and their importance in many personal, social, and global contexts. Accordingly, it seems reasonable to expect individuals to have an interest in science, to support the process of scientific enquiry and to act responsibly towards natural resources and the environment.

What is important for individuals to be able to do that is science-related? People often have to draw appropriate conclusions from evidence and information given to them; they have to evaluate claims made by others on the basis of the evidence put forward and they have to distinguish personal opinion from evidence-based statements. Often the evidence involved is scientific, but science has a more general role to play as well since it is concerned with rationality in testing ideas and theories against evidence. Of course this does not deny that science includes creativity and imagination, attributes that have always played a central part in advancing human understanding of the world.

Can citizens distinguish claims that are scientifically sound from those that are not? Ordinary citizens are generally not called on to judge the worth of major theories or potential advances in science. But they do make decisions based on the facts in advertisements, evidence in legal matters, information about their health, and issues concerning local environments and natural resources. An educated person should be able to distinguish the kinds of questions that can be answered by scientists and the kinds of problems that can be solved by science-based technologies from those that cannot be answered in these ways.

DEFINING THE DOMAIN

Current thinking about the desired outcomes of science education emphasises scientific knowledge (including knowledge of the scientific approach to enquiry) and an appreciation of science's contribution to society. These outcomes require an understanding of important concepts and explanations of science, and of the strengths and limitations of science in the world. They imply a critical stance and a reflective approach to science (Millar & Osborne, 1998).

Such goals provide an orientation and emphasis for the science education of all people (Fensham, 1985). The competencies assessed in PISA are broad and include aspects that relate to personal utility, social responsibility, and the intrinsic and extrinsic value of scientific knowledge.

The above discussion frames a central point of the PISA science assessment: the assessment should focus on scientific competencies that clarify what 15-year-old students know, value and are able to do within reasonable and appropriate personal, social and global contexts. This perspective differs from one grounded exclusively in school science programmes and extensively based only on the disciplines of science; but it includes problems situated in educational contexts and also in professional ones, and recognises the essential place of the knowledge, methods, attitudes, and values that define scientific disciplines (Bybee, 1997b; Fensham, 2000; Gräber & Bolte, 1997; Mayer, 2002; Roberts, 1983; UNESCO, 1993).

PISA is concerned with both the cognitive and affective aspects of students' competencies in science. The cognitive aspects include students' knowledge and their capacity to use this knowledge effectively, as they carry out certain cognitive processes that are characteristic of science and scientific enquiries of personal, social, or global relevance. In assessing scientific competencies, PISA is concerned with issues to which scientific knowledge can contribute and which will involve students, either now or in the future, in making decisions. From the point of view of their scientific competencies, students respond to such issues in terms of their understanding of relevant scientific knowledge, their ability to access and evaluate information, their ability to interpret evidence bearing on the issue and their ability to identify the scientific and technological aspects of the issue (Koballa, Kemp & Evans, 1997; Law, 2002). PISA also is concerned with non-cognitive aspects: how students respond affectively. Attitudinal aspects of their response engage their interest, sustain their support, and motivate them to take action (Schibeci, 1984).

Box 3.1 ■ Scientific knowledge: PISA terminology

The term scientific knowledge is used throughout this framework to refer to both knowledge of science and knowledge about science. Knowledge of science refers to knowledge of the natural world across the major fields of physics, chemistry, biological science, Earth and space science, and science-based technology. Knowledge about science refers to knowledge of the means (scientific enquiry) and goals (scientific explanations) of science.

The PISA science assessment encompasses a continuum of scientific knowledge and the cognitive abilities associated with scientific enquiry, incorporates multiple dimensions, and addresses the relationships between science and technology. It provides an assessment of students' scientific literacy by assessing their capacity to use scientific knowledge (Bybee, 1997a; Fensham, 2000; Law, 2002; Mayer & Kumano, 2002).

Box 3.2 ■ PISA scientific literacy

For the purposes of PISA, scientific literacy refers to an individual's:

- Scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues
- Understanding of the characteristic features of science as a form of human knowledge and enquiry
- Awareness of how science and technology shape our material, intellectual and cultural environments
- Willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen

Scientific literacy

The following remarks clarify the definition of scientific literacy as defined for the purposes of PISA.

Using the term "scientific literacy" rather than "science" underscores the importance that the PISA science assessment places on the application of scientific knowledge in the context of life situations, compared with the simple reproduction of traditional school science knowledge. The functional use of knowledge requires the application of those processes that are characteristic of science and scientific enquiry (here termed the scientific competencies) and is regulated by the individual's appreciation, interest, values, and action relative to scientific matters. A student's ability to carry out the scientific competencies involves both knowledge of science and an understanding of the characteristics of science as a way of acquiring knowledge (*i.e.* knowledge about science). The definition also recognises that the disposition to carry out these competencies depends upon an individual's attitudes towards science and a willingness to engage in science-related issues.

Knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena and to draw evidence-based conclusions

Knowledge for this definition implies far more than the ability to recall information, facts, and names. The definition includes knowledge of science (knowledge about the natural world) and knowledge about science itself. Knowledge of science includes understanding fundamental scientific concepts and theories; knowledge about science includes understanding the nature of science as a human activity and the power and limitations of scientific knowledge. The questions to be identified are those that can be answered by scientific enquiry, again requiring knowledge about science as well as scientific knowledge of the specific topics involved. Of significance is that individuals must often acquire new knowledge not through their own scientific investigations, but through resources such as libraries and the Internet. Drawing evidence-based conclusions means knowing, selecting and evaluating information and data,

while recognising that there is often not sufficient information to draw definite conclusions, thus making it necessary to speculate cautiously and consciously about the information that is available.

Characteristic features of science as a form of human knowledge and enquiry

As expressed here, being scientifically literate implies that students should have some understanding of how scientists obtain data and propose explanations, and recognise key features of scientific investigations and the types of answers one can reasonably expect from science. For example, scientists use observations and experiments to gather data about objects, organisms and events in the natural world. The data are used to propose explanations that become public knowledge and may be used in various forms of human activity. Some key features of science include: the collection and use of data – data collection is guided by ideas and concepts (sometimes stated as hypotheses) and includes issues of relevance, context and accuracy; the tentative nature of knowledge claims; an openness to sceptical review; the use of logical arguments; and, the obligation to make connections to current and historical knowledge, and to report the methods and procedures used in obtaining evidence.

How science and technology shape our material, intellectual, and cultural environments

The key points in this statement include the idea that science is a human endeavour, one that influences our societies and us as individuals. Further, technological development is also a human endeavour (Fleming, 1989). Although science and technology differ in aspects of their purposes, processes, and products, they are also closely related and, in many respects, complementary. In this regard, the definition of scientific literacy as used here includes the nature of science and of technology and their complementary relationships. As individuals we make decisions through public policies that influence the directions of science and technology. Science and technology play paradoxical roles in society as they propose answers to questions and provide solutions to problems, but may also create new questions and problems.

Willingness to engage in science-related issues and with the ideas of science as a reflective citizen

The meaning conveyed in the first part of this statement, 'willingness to engage in science-related issues', is wider than taking note and taking action as required; it implies having continuing interest in, having opinions about and participating in current and future science-based issues. The second part of the statement, 'with the ideas of science as a reflective citizen', covers various aspects of attitudes and values that individuals may have towards science. The whole phrase implies a person who has an interest in scientific topics, thinks about science-related issues, is concerned about issues of technology, resources and the environment, and reflects on the importance of science in personal and social perspectives.

Inevitably, scientific competencies draw upon reading and mathematical competencies (Norris & Phillips, 2003). For example, aspects of mathematical competencies are required in data interpretation contexts. Similarly, *reading literacy* is necessary when a student is demonstrating an understanding of scientific terminology. The intersection of these other domains with the PISA definition and assessment of science cannot be avoided; however, at the core of each assessment task there should be aspects that relate unambiguously to science competency.

ORGANISING THE DOMAIN

The definition of the science domain proposed here provides for a continuum in which individuals are deemed to be more or less scientifically literate; they are not regarded as either scientifically literate or scientifically illiterate (Bybee, 1997a; 1997b). So, for example, the student with less developed *scientific literacy* might be able to recall simple scientific factual knowledge and to use common scientific knowledge in drawing or evaluating conclusions. A student with more developed *scientific literacy* will demonstrate the ability to create and use conceptual models to make predictions and give explanations, analyse scientific investigations, relate data as evidence, evaluate alternative explanations of the same phenomena, and communicate conclusions with precision.

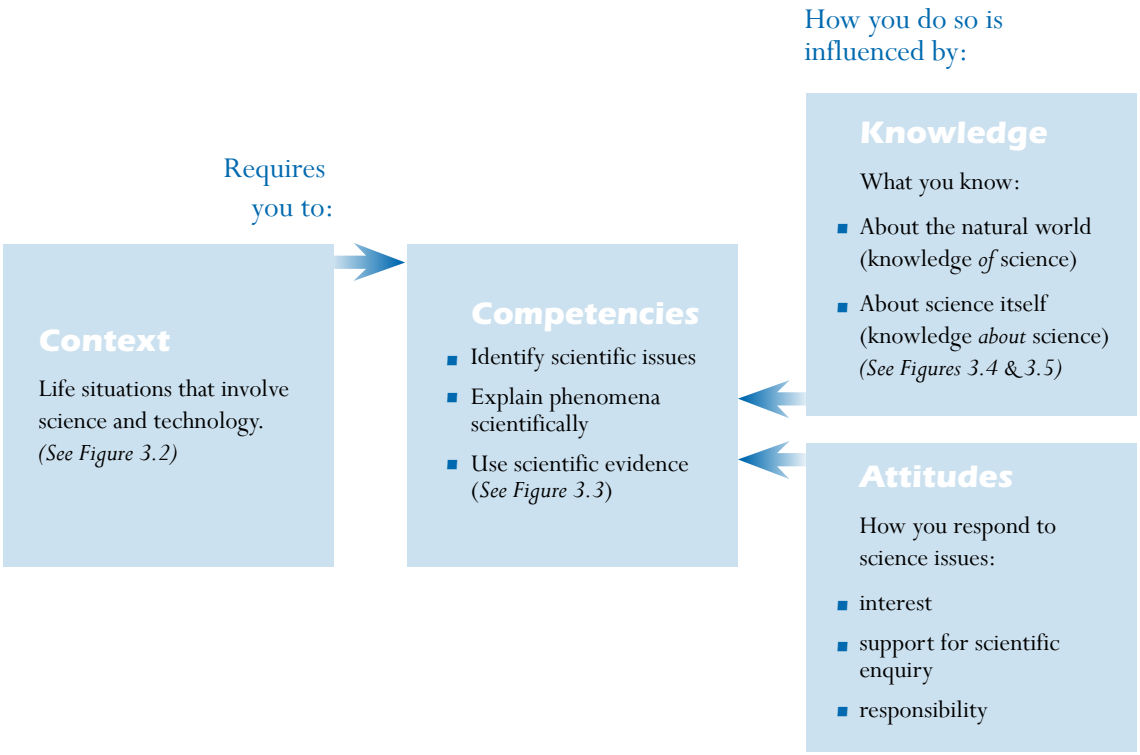
For assessment purposes, the PISA definition of *scientific literacy* may be characterised as consisting of four interrelated aspects (see Figure 3.1):

- *Context*: recognising life situations involving science and technology.
- *Knowledge*: understanding the natural world on the basis of scientific knowledge that includes both knowledge of the natural world, and knowledge about science itself.
- *Competencies*: demonstrating scientific competencies that include identifying scientific issues, explaining phenomena scientifically, and drawing conclusions based on evidence.
- *Attitudes*: indicating an interest in science, support for scientific enquiry, and motivation to act responsibly towards, for example, natural resources and environments.

The following sections restate and elaborate these interrelated aspects. In highlighting these aspects, the PISA science framework has ensured that the focus of the assessment is upon the outcomes of science education. Several questions have guided the establishment of the PISA science framework. They are:

- What *contexts* would be appropriate for assessing 15-year-old students?
- What *competencies* might we reasonably expect 15-year-old students to demonstrate?
- What *knowledge* might we reasonably expect 15-year-old students to demonstrate?
- What *attitudes* might we reasonably expect 15-year-old students to demonstrate?

Figure 3.1 ■ **Framework for PISA science assessment**



Situations and context

An important aspect of the PISA science assessment is engagement with science in a variety of situations. In dealing with scientific issues, the choice of methods and representations is often dependent on the situations in which the issues are presented.

The situation is the part of the student's world in which the tasks are placed. Assessment items are framed in situations of general life and not limited to life in school. In the PISA science assessment, the focus of the items

is on situations relating to the self, family and peer groups (*personal*), to the community (*social*) and to life across the world (*global*). A further type of setting, appropriate to some topics, is the *historical* one, in which understanding of the advances in scientific knowledge can be assessed.

PISA assesses important scientific knowledge relevant to the science education curricula of participating countries without being constrained to the common aspects of participants' national curricula. The assessment does this by requiring evidence of the successful use of science knowledge and skills in important situations reflecting the world and in accordance with PISA's focus. This, in turn, involves the application of selected knowledge about the natural world, and about science itself, and evaluation of students' attitudes towards scientific matters.

Figure 3.2 lists the main applications of science that are involved within *personal*, *social*, and *global* settings as the contexts, or specific situations, for assessment exercises. However, other settings (e.g. *technological, historical*) and areas of application are also used. The areas of application are: health , natural resources , the environment , hazards , and the frontiers of science and technology . They are the areas in which science has particular value for individuals and communities in enhancing and sustaining quality of life, and in the development of public policy.

The PISA science assessment is not an assessment of contexts. It assesses competencies, knowledge and attitudes as these are presented or relate to contexts. In selecting the contexts, it is important to keep in mind that the purpose of the assessment is to assess scientific competencies, understandings, and attitudes that students have acquired by the end of the compulsory years of schooling.

PISA items are arranged in groups (*units*) based around a common stimulus that establishes the context for the items. The contexts used are chosen in the light of relevance to students' interests and lives. The items are developed keeping in mind linguistic and cultural differences in participating countries.

Figure 3.2 ■ **Contexts for PISA science assessment**

	Personal (self, family and peer groups)	**Social** (the community)	**Global** (life across the world)
Health	maintenance of health, accidents, nutrition	control of disease, social transmission, food choices, community health	epidemics, spread of infectious diseases
Natural resources	personal consumption of materials and energy	maintenance of human populations, quality of life, security, production and distribution of food, energy supply	renewable and non-renewable energy sources, natural systems, population growth, sustainable use of species
Environment	environmentally friendly behaviour, use and disposal of materials	population distribution, disposal of waste, environmental impact, local weather	biodiversity, ecological sustainability, control of pollution, production and loss of soil
Hazard	natural and human-induced, decisions about housing	rapid changes (earthquakes, severe weather), slow and progressive changes (coastal erosion, sedimentation), risk assessment	climate change, impact of modern warfare
Frontiers of science and technology	interest in science's explanations of natural phenomena, science-based hobbies, sport and leisure, music and personal technology	new materials, devices and processes, genetic modification, weapons technology, transport	extinction of species, exploration of space, origin and structure of the universe

Science examples

In this section, three examples of science units from the PISA 2006 assessment are presented. They are referred to throughout the remainder of the chapter to illustrate the variety of contexts involved, the scientific competencies and areas of scientific knowledge addressed by PISA science items, and the item types (formats) employed. In addition, the scoring guide for each item is shown (for a description of proficiency levels, see Figure 3.10).

Science example 1

Science example 1 is a unit titled *ACID RAIN*. The stimulus material is a photograph of statues on the Acropolis in Athens, together with a brief statement explaining that the original statues were moved inside the museum of the Acropolis due to their deterioration from acid rain. The area of application is Hazards within personal and social settings.

SCIENCE EXAMPLE 1: ACID RAIN

Below is a photo of statues called Caryatids that were built on the Acropolis in Athens more than 2500 years ago. The statues are made of a type of rock called marble. Marble is composed of calcium carbonate.

In 1980, the original statues were transferred inside the museum of the Acropolis and were replaced by replicas. The original statues were being eaten away by acid rain.

Question 1: ACID RAIN

Normal rain is slightly acidic because it has absorbed some carbon dioxide from the air. Acid rain is more acidic than normal rain because it has absorbed gases like sulfur oxides and nitrogen oxides as well.

Where do these sulfur oxides and nitrogen oxides in the air come from?

.....

.....

Full Credit (Level 3: 506)

Any one of car exhausts, factory emissions, *burning* fossil fuels such as oil and coal, gases from volcanoes or other similar things *OR* Responses that include an incorrect as well as a correct source of the pollution *OR* Responses that refer to "pollution" but do not give a source of pollution that is a significant cause of acid rain.

The effect of acid rain on marble can be modelled by placing chips of marble in vinegar overnight. Vinegar and acid rain have about the same acidity level. When a marble chip is placed in vinegar, bubbles of gas form. The mass of the dry marble chip can be found before and after the experiment.

Question 2: ACID RAIN

A marble chip has a mass of 2.0 grams before being immersed in vinegar overnight. The chip is removed and dried the next day. What will the mass of the dried marble chip be?

A. Less than 2.0 grams

B. Exactly 2.0 grams

C. Between 2.0 and 2.4 grams

D. More than 2.4 grams

Full Credit (Level 2: 460)

A. Less than 2.0 grams

Question 3: ACID RAIN

Students who did this experiment also placed marble chips in pure (distilled) water overnight.

Explain why the students included this step in their experiment.

.....

.....

Full Credit (Level 6: 717)

To show that the acid (vinegar) is necessary for the reaction.

Partial Credit (Level 3: 513)

To compare with the test of vinegar and marble, but it is not made clear that this is being done to show that the acid (vinegar) is necessary for the reaction.

Science example 2

Science example 2 is titled *GREENHOUSE* and deals with the increase of the average temperature of the Earth's atmosphere. The stimulus material consists of a short text introducing the term "Greenhouse effect" and includes graphical information on the average temperature of the Earth's atmosphere and the carbon dioxide emission on the Earth over time.

The area of application is Environment within a global setting.

SCIENCE EXAMPLE 2: GREENHOUSE

Read the texts and answer the questions that follow.

THE GREENHOUSE EFFECT: FACT OR FICTION?

Living things need energy to survive. The energy that sustains life on the Earth comes from the Sun, which radiates energy into space because it is so hot. A tiny proportion of this energy reaches the Earth.

The Earth's atmosphere acts like a protective blanket over the surface of our planet, preventing the variations in temperature that would exist in an airless world.

Most of the radiated energy coming from the Sun passes through the Earth's atmosphere. The Earth absorbs some of this energy, and some is reflected back from the Earth's surface. Part of this reflected energy is absorbed by the atmosphere.

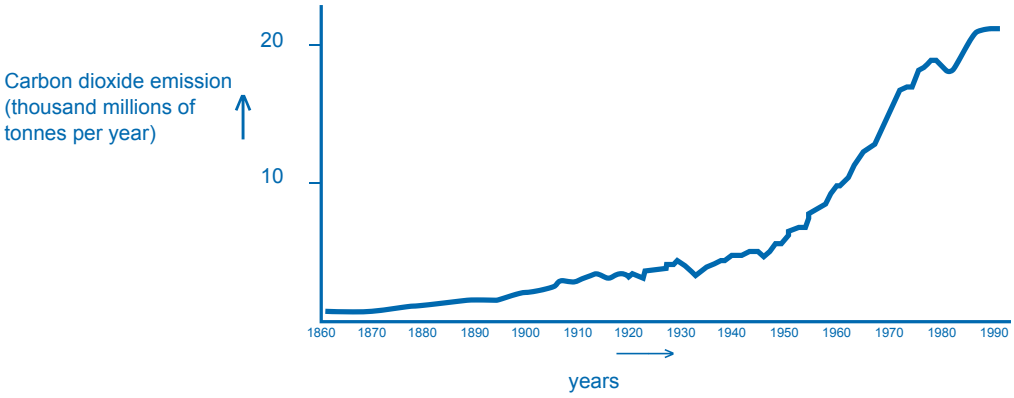
As a result of this the average temperature above the Earth's surface is higher than it would be if there were no atmosphere. The Earth's atmosphere has the same effect as a greenhouse, hence the term greenhouse effect.

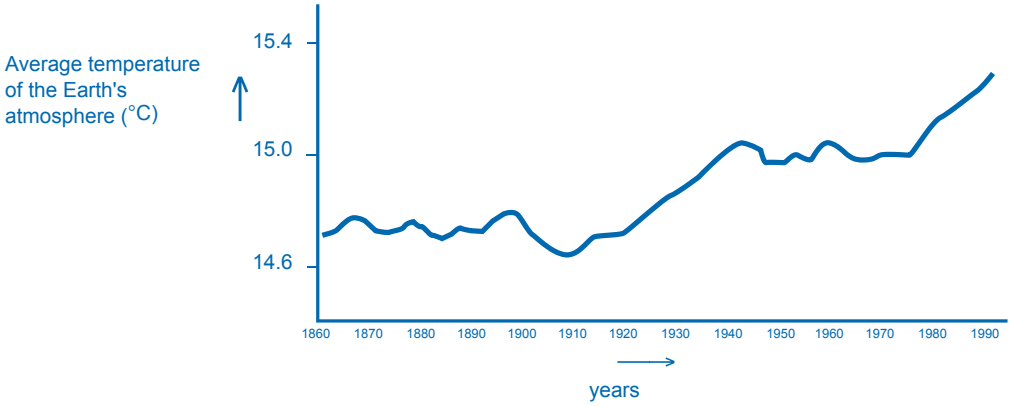
The greenhouse effect is said to have become more pronounced during the twentieth century.

It is a fact that the average temperature of the Earth's atmosphere has increased. In newspapers and periodicals the increased carbon dioxide emission is often stated as the main source of the temperature rise in the twentieth century.

A student named Andr□ becomes interested in the possible relationship between the average temperature of the Earth's atmosphere and the carbon dioxide emission on the Earth.

In a library he comes across the following two graphs.





Andr□ concludes from these two graphs that it is certain that the increase in the average temperature of the Earth's atmosphere is due to the increase in the carbon dioxide emission.

Question 1: GREENHOUSE

What is it about the graphs that supports André's conclusion?

.....

.....

Full Credit (Level 3: 529)

Refers to the increase of both (average) temperature and carbon dioxide emission OR Refers (in general terms) to a positive relationship between temperature and carbon dioxide emission.

Question 2: GREENHOUSE

Another student, Jeanne, disagrees with André's conclusion. She compares the two graphs and says that some parts of the graphs do not support his conclusion.

Give an example of a part of the graphs that does not support André's conclusion. Explain your answer.

.....

.....

.....

Full Credit (Level 5: 659)

Refers to one particular part of the graphs in which the curves are not both descending or both climbing and gives the corresponding explanation.

Partial Credit (Level 4: 568)

Mentions a correct period, without any explanation OR Mentions only one particular year (not a period of time), with an acceptable explanation OR Gives an example that doesn't support André's conclusion but makes a mistake in mentioning the period OR Refers to differences between the two curves, without mentioning a specific period OR Refers to an irregularity in one of the graphs OR Indicates difference in the graphs, but explanation is poor.

Question 3: GREENHOUSE

André persists in his conclusion that the average temperature rise of the Earth's atmosphere is caused by the increase in the carbon dioxide emission. But Jeanne thinks that his conclusion is premature. She says: "Before accepting this conclusion you must be sure that other factors that could influence the greenhouse effect are constant".

Name one of the factors that Jeanne means.

.....

.....

Full Credit (Level 6: 709)

Gives a factor referring to the energy/radiation coming from the Sun OR Gives a factor referring to a natural component or a potential pollutant.

Science example 3

Science example 3 titled *PHYSICAL EXERCISE* is concerned with the effect of physical exercise on personal health.

SCIENCE EXAMPLE 3: PHYSICAL EXERCISE

Regular but moderate physical exercise is good for our health.

Question 1: PHYSICAL EXERCISE

What are the advantages of regular physical exercise? Circle "Yes" or "No" for each statement.

Is this an advantage of regular physical exercise?	Yes or No?
Physical exercise helps prevent heart and circulation illnesses.	Yes / No
Physical exercise leads to a healthy diet.	Yes / No
Physical exercise helps to avoid becoming overweight.	Yes / No

Full Credit (Level 3: 545)

All three correct: Yes, No, Yes in that order.

Question 2: PHYSICAL EXERCISE

What happens when muscles are exercised? Circle "Yes" or "No" for each statement.

Does this happen when muscles are exercised?	Yes or No?
Muscles get an increased flow of blood.	Yes / No
Fats are formed in the muscles.	Yes / No

Full Credit (Level 1: 386)

Both correct: Yes, No in that order.

Question 3: PHYSICAL EXERCISE

Why do you have to breathe more heavily when you're doing physical exercise than when your body is resting?

.....

.....

.....

Full Credit (Level 4: 583)

To remove increased levels of carbon dioxide and to supply more oxygen to your body OR To remove increased levels of carbon dioxide from your body or to supply more oxygen to your body, but not both.

Scientific competencies

The PISA science assessment gives priority to the competencies listed in Figure 3.3: the ability to identify scientifically-oriented issues; describe, explain or predict phenomena based on scientific knowledge; interpret evidence and conclusions, and use scientific evidence to make and communicate decisions. Demonstrating these competencies in the PISA assessment involves applying scientific knowledge – both knowledge of science and knowledge about science itself as a form of knowledge and an approach to enquiry.

Figure 3.3 ■ **PISA scientific competencies**

Identifying scientific issues

- Recognising issues that are possible to investigate scientifically
- Identifying keywords to search for scientific information
- Recognising the key features of a scientific investigation

Explaining phenomina scientifically

- Applying knowledge of science in a given situation
- Describing or interpreting phenomena scientifically and predicting changes
- Identifying appropriate descriptions, explanations, and predictions

Using scientific evidence

- Interpreting scientific evidence and making and communicating conclusions
- Identifying the assumptions, evidence and reasoning behind conclusions
- Reflecting on the societal implications of science and technological developments

Some cognitive processes have special meaning and relevance for *scientific literacy*. Among the cognitive processes that are implied in the scientific competencies are: inductive reasoning (reasoning from detailed facts to general principles) and deductive reasoning (reasoning from the general to the particular), critical and integrated thinking, transforming representations (*e.g.* data to tables, tables to graphs), constructing and communicating arguments and explanations based on data, thinking in terms of models, and using mathematical processes, knowledge and skills.

Justification for an emphasis on the *scientific competencies* of Figure 3.3 in PISA rests on the importance of these competencies for scientific investigation. They are grounded in logic, reasoning, and critical analysis. An elaboration of the scientific competencies follows, including references to how they are assessed in the science examples presented in the previous section

Identifying scientific issues

It is important to be able to distinguish scientific issues and content from other forms of issues. Importantly, scientific issues must lend themselves to answers based on scientific evidence. The competency *identifying scientific issues* includes recognising questions that it would be possible to investigate scientifically in a given situation and identifying keywords to search for scientific information on a given topic. It also includes recognising key features of a scientific investigation: for example, what things should be compared, what variables should be changed or controlled, what additional information is needed, or what action should be taken so that relevant data can be collected.

Identifying scientific issues requires students to possess knowledge about science itself, and may also draw, to varying degrees, on their knowledge of science. For example, Question 3 of ACID RAIN (Science example 1) requires students to answer a question about the control in a scientific investigation. Students must compare an acid (vinegar) reaction to possible reactions with pure water to be sure that acid is the cause of the reaction.

Explaining phenomena scientifically

Demonstrating the competency *explaining phenomena scientifically* involves applying appropriate knowledge of science in a given situation. The competency includes describing or interpreting phenomena and predicting changes, and may involve recognising or identifying appropriate descriptions, explanations, and predictions. An example of a PISA item that requires students to explain phenomena scientifically is Question 1 of ACID RAIN (Science example 1), where students must explain the origin of sulfur oxides and nitrogen oxides in the air. Other examples are: Question 3 of GREENHOUSE (Science example 2), which requires students to identify factors causing the average temperature rise of the Earth, and Question 3 of PHYSICAL EXERCISE (Science example 3) which asks students to apply their knowledge of the human respiratory system.

Using scientific evidence

The competency *using scientific evidence* includes accessing scientific information and producing arguments and conclusions based on scientific evidence (Kuhn, 1992; Osborne, Erduran, Simon & Monk, 2001). The required response can involve knowledge about science or knowledge of science or both. Question 2 of *ACID RAIN* (Science example 1) requires students to use the information provided to form a conclusion about the effects of vinegar on marble, a simple model for the influence of acid rain on marble. Other examples are Questions 1 and 2 of *GREENHOUSE* (Science example 2), both of which require students to interpret evidence presented in two graphs.

The competency also involves: selecting from alternative conclusions in relation to evidence; giving reasons for or against a given conclusion in terms of the process by which the conclusion was derived from the data provided; and identifying the assumptions made in reaching a conclusion. Reflecting on the societal implications of scientific or technological developments is another aspect of this competency.

Students may be required to express their evidence and decisions to a specified audience, through their own words, diagrams or other representations as appropriate. In short, students should be able to present clear and logical connections between evidence and conclusions or decisions.

Scientific knowledge

As previously noted (see Box 3.1), scientific knowledge refers to both *knowledge of science* (knowledge about the natural world) and *knowledge about science* itself.

Knowledge of science

Given that only a sample of students' knowledge of science can be assessed in any one PISA assessment, it is important that clear criteria are used to guide the selection of knowledge that is assessed. Moreover, the objective of PISA is to describe the extent to which students can apply their knowledge in contexts of relevance

to their lives. Accordingly, the assessed knowledge will be selected from the major fields of physics, chemistry, biology, Earth and space science, and technology according to the following criteria:

- The relevance to real-life situations: scientific knowledge differs in the degree to which it is useful in the life of individuals.
- The knowledge selected represents important scientific concepts and thus has enduring utility.
- The knowledge selected is appropriate to the developmental level of 15-year-old students.

Figure 3.4 shows the *knowledge of science* categories and examples of content selected by applying these criteria. This knowledge is required for understanding the natural world and for making sense of experiences in *personal*, *social* and *global* situations. The framework uses the term systems instead of sciences in the descriptors of the major fields to convey the idea that citizens have to apply their understanding of concepts from the physical and life sciences, Earth and space science, and technology, in situations that interact in more or less united ways.

Figure 3.4 ■ **PISA categories of *knowledge of science***

Physical systems

- Structure of matter (*e.g.* particle model, bonds)
- Properties of matter (*e.g.* changes of state, thermal and electrical conductivity)
- Chemical changes of matter (*e.g.* reactions, energy transfer, acids/bases)
- Motions and forces (*e.g.* velocity, friction)
- Energy and its transformation (*e.g.* conservation, dissipation, chemical reactions)
- Interactions of energy and matter (*e.g.* light and radio waves, sound and seismic waves)

Living systems

- Cells (*e.g.* structures and function, DNA, plant and animal)
- Humans (*e.g.* health, nutrition, subsystems [*i.e.* digestion, respiration, circulation, excretion, and their relationship], disease, reproduction)
- Populations (*e.g.* species, evolution, biodiversity, genetic variation)
- Ecosystems (*e.g.* food chains, matter and energy flow)
- Biosphere (*e.g.* ecosystem services, sustainability)

Earth and space systems

- Structures of Earth systems (*e.g.* lithosphere, atmosphere, hydrosphere)
- Energy in Earth systems (*e.g.* sources, global climate)
- Change in Earth systems (*e.g.* plate tectonics, geochemical cycles, constructive and destructive forces)
- Earth's history (*e.g.* fossils, origin and evolution)
- Earth in space (*e.g.* gravity, solar systems)

Technology systems

- Role of science-based technology (*e.g.* solve problems, help humans meet needs and wants, design and conduct investigations)
- Relationships between science and technology (*e.g.* technologies contribute to scientific advancement)
- Concepts (*e.g.* optimisation, trade-offs, cost, risk, benefit)
- Important principles (*e.g.* criteria, constraints, innovation, invention, problem solving)

The examples listed in Figure 3.4 convey the meanings of the categories; there is no attempt to list comprehensively all the knowledge that could be related to each of the knowledge of science categories.

Question 2 of *ACID RAIN* (Science example 1) assesses students' knowledge of science in the category "Physical systems . Question 3 of *ACID RAIN* focuses on students' knowledge about science in the category "Scientific enquiry," but assumes some knowledge of science (category "Physical systems") that students can be expected to possess.

Question 3 of *GREENHOUSE* (Science example 2) is concerned with students' knowledge of "Earth and space systems ; and Questions 1, 2 and 3 of *PHYSICAL EXERCISE* (Science example 3) assess students' knowledge of "Living systems".

Knowledge about science

Figure 3.5 displays the categories and examples of content for *knowledge about science*. The first category, "Scientific enquiry," centres on enquiry as the central process of science and the various components of that process. The second category, closely related to enquiry, is "Scientific explanations". Scientific explanations are the results of scientific enquiry. One can think of enquiry as the means of science (how scientists get data) and explanations as the goals of science (how scientists use data). The examples listed in Figure 3.5 convey the general meanings of the categories; there is no attempt to list comprehensively all the knowledge that could be related to each category.

Figure 3.5 ■ **PISA categories of *knowledge about science***

Scientific enquiry

- Origin (*e.g.* curiosity, scientific questions)
- Purpose (*e.g.* to produce evidence that helps answer scientific questions, current ideas/models/theories guide enquiries)
- Experiments (*e.g.* different questions suggest different scientific investigations, design)
- Data type (*e.g.* quantitative [measurements], qualitative [observations])
- Measurement (*e.g.* inherent uncertainty, replicability, variation, accuracy/precision in equipment and procedures)
- Characteristics of results (*e.g.* empirical, tentative, testable, falsifiable, self-correcting)

Scientific explanations

- Types (*e.g.* hypothesis, theory, model, law)
- Formation (*e.g.* data representation, role of extant knowledge and new evidence, creativity and imagination, logic)
- Rules (*e.g.* must be logically consistent; based on evidence, historical and current knowledge)
- Outcomes (*e.g.* produce new knowledge, new methods, new technologies; lead to new questions and investigations)

Question 3 of *ACID RAIN* (Science example 1) is an example of knowledge about science in the category "Scientific enquiry." The question requires students to identify the possible purposes for a control of an investigation (competency: Identifying Scientific Issues).

Questions 1 and 2 of *GREENHOUSE* (Science example 2) are knowledge about science items. Both of these items belong to the category "Scientific explanations." In Question 1, students must interpret evidence presented in two graphs and argue that the graphs together support an explanation that an increase in the Earth's average

temperature is due to an increase in carbon dioxide emissions. Question 2 asks students to use evidence from the same graphs to support a different conclusion.

Attitudes towards science

Individuals' attitudes play a significant role in their interest and response to science and technology in general and to issues that affect them in particular. One goal of science education is for students to develop attitudes that make them likely to attend to scientific issues and subsequently to acquire and apply scientific and technological knowledge for personal, social, and global benefit.

PISA's attention to attitudes towards science is based on the belief that a person's scientific literacy includes certain attitudes, beliefs, motivational orientations, sense of self-efficacy, values, and ultimate actions. This is supported by and builds upon Klopfer's (1976) structure for the affective domain in science education, as well as reviews of attitudinal research (for example, Gardner, 1975, 1984; Gauld & Hukins, 1980; Blosser, 1984; Laforgia, 1988; Osborne, Simon & Collins, 2003; Schibeci, 1984) and research into students' attitudes towards the environment (for example, Bogner & Wiseman, 1999; Eagles & Demare, 1999; Weaver, 2002; Rickinson, 2001).

In PISA 2006, when science was the major domain assessed, an assessment of students' attitudes and values was included using the student questionnaire and through contextualised questions posed immediately after the test questions in many units (OECD, 2006). These contextualised questions were related to the issues addressed in the test questions. However, since science constitutes a minor part of the assessment in PISA 2009, the assessment will not contain any contextualised (embedded) attitudinal items.

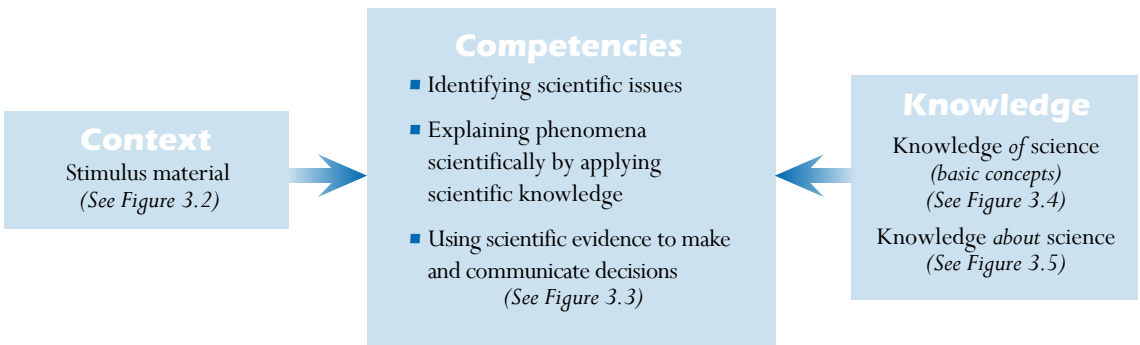
ASSESSING SCIENCE IN PISA

Test characteristics

In accordance with the PISA definition of *scientific literacy*, test questions (items) require the use of the scientific competencies (see Figure 3.3) within a context (see Figure 3.2). This involves the application of scientific knowledge (see Figures 3.4 and 3.5).

Figure 3.6 is a variation of Figure 3.1 that presents the basic components of the PISA framework for science assessment in a way that can be used to relate the framework with the structure and the content of assessment units. Figure 3.6 may be used both synthetically as a tool to plan assessment exercises, and analytically as a tool to study the results of standard assessment exercises. As a starting point to construct assessment units, we could consider the contexts that would serve as stimulus material, the scientific competencies required to respond to the questions or issues, or the scientific knowledge central to the exercise.

Figure 3.6 ■ **A tool for constructing and analysing assessment units and items**



A test unit is comprised of a group of independently scored questions (items) of various types, accompanied by stimulus material that establishes the context for the items. Many different types of stimulus are used, often in combination, to establish the context, including passages of text, photographs, tables, graphs, and diagrams, often in combination. The range of stimulus material is illustrated by the three units included in this chapter. *GREENHOUSE* (Science example 2) has an extensive stimulus comprised of half a page of text and two graphs, whereas the stimulus of *PHYSICAL EXERCISE* (Science example 3) is atypical in its brevity and reliance on visual suggestion.

The reason PISA employs this unit structure is to facilitate the use of contexts that are as relevant as possible, and that reflect the complexity of real situations, while making efficient use of testing time. Using situations about which several questions can be posed, rather than asking separate questions about a larger number of different situations, reduces the overall time required for a student to become familiar with the material relating to each question. However, the need to make each scored point independent of others within a unit needs to be taken into account. It is also necessary to recognise that, because this approach reduces the number of different assessment contexts, it is important to ensure that there is an adequate range of contexts so that bias due to the choice of contexts is minimised.

PISA 2009 science test units incorporate up to four cognitive items that assess students' scientific competencies. Each item involves the predominant use of the skills involved in one of the scientific competencies, and primarily requires knowledge of science or knowledge about science. In most cases, more than one competency and more than one knowledge category are assessed (by different items) in this way within a unit.

Four types of items are used to assess the competencies and scientific knowledge identified in the framework: simple multiple-choice items, closed constructed-response items, complex multiple-choice items, and open constructed-response items. About one-third of the items are simple multiple-choice items, like Question 2 of *ACID RAIN* (Science example 1), which require the selection of a single response from four options. Another third of the items either require closed constructed-responses, or are complex multiple-choice items. Questions 1 and 2 of *PHYSICAL EXERCISE* (Science example 3), which require students to respond to a series of related "Yes/No" questions, are typical complex multiple-choice items. The remaining third of the items are open constructed-response items, like the remaining questions in *ACID RAIN* and *PHYSICAL EXERCISE* and the three items in *GREENHOUSE* (Science example 2). These require a relatively extended written or drawn response from students.

While the majority of items are dichotomously scored (that is, responses are either given all credit or no credit), some of the open constructed-response items allow for partial credit, and give students credit for having a partially correct answer. The categories "Full credit", "Partial credit" and "No credit" divide students' responses into three groups in terms of the extent to which the students demonstrate the ability to answer a question. A Full credit response requires a student to show a level of understanding of the topic that is appropriate for a scientifically literate 15-year-old student. Less sophisticated or correct responses may qualify for "Partial credit", with completely incorrect, irrelevant or missing responses being assigned No credit . Question 3 of *ACID RAIN* (Science example 1) and Question 2 of *GREENHOUSE* (Science example 2) are partial credit items.

The need for students to possess a degree of *reading literacy* in order to understand and answer written questions on science raises an issue of the level of *reading literacy* required. Stimulus material and questions use language that is as clear, simple and brief as possible, while still conveying the appropriate meaning. The number of concepts introduced per paragraph is limited and questions that require too high a level of reading, or mathematics, are avoided.

Science assessment structure

Each PISA assessment must include an appropriate balance of items assessing scientific knowledge and competencies. Figure 3.7 shows the distribution of score points among the *knowledge of science and knowledge about science* categories, expressed as percentages of the total score points, for both PISA 2006 (when science was the major domain) and PISA 2009.

Figure 3.7 ■ Distribution of score points for knowledge

	Percentage of score points	
Knowledge *of* science	**PISA 2006**	**PISA 2009**
Physical systems	17	13
Living systems	20	16
Earth and space systems	10	12
Technological systems	8	9
Subtotal	55	50
Knowledge *about* science		
Scientific enquiry	23	23
Scientific explanations	22	27
Subtotal	45	50
Total	100	100

The corresponding distributions for the scientific competencies are given in Figure 3.8.

Figure 3.8 ■ Distribution of score points for scientific competencies

	Percentage of score points	
Scientific competencies	**2006**	**2009**
Identifying scientific issues	22	23
Explaining phenomena scientifically	46	41
Using scientific evidence	32	37
Total	**100**	**100**

Item contexts are spread across personal, social and global settings approximately in the ratio 1:2:1, and there is a roughly even selection of areas of application as listed in Figure 3.2.

The distributions for item types are given in Figure 3.9.

Figure 3.9 ■ Distribution of score points for item types

	Percentage of score points	
Item types	**2006**	**2009**
Simple multiple-choice	35	32
Complex multiple-choice	27	34
Closed constructed-response	4	2
Open constructed-response	34	32
Total	**100**	**100**

Figure 3.10 ■ Summary descriptions of the six proficiency levels in science

	Lower score limit	Examples of items at each level	What students can typically do at each level
Level 6	707.9	ACID RAIN Q3 Full credit (717) GREENHOUSE Q3 (709)	At Level 6, students can consistently identify, explain and apply scientific knowledge and knowledge about science in a variety of complex life situations. They can link different information sources and explanations and use evidence from those sources to justify decisions. They clearly and consistently demonstrate advanced scientific thinking and reasoning, and they use their scientific understanding in support of solutions to unfamiliar scientific and technological situations. Students at this level can use scientific knowledge and develop arguments in support of recommendations and decisions that centre on personal, social or global situations.
Level 5	633.3	GREENHOUSE Q2 Full credit (659)	At Level 5, students can identify the scientific components of many complex life situations, apply both scientific concepts and knowledge about science to these situations, and can compare, select and evaluate appropriate scientific evidence for responding to life situations. Students at this level can use well-developed inquiry abilities, link knowledge appropriately and bring critical insights to situations. They can construct explanations based on evidence and arguments based on their critical analysis.
Level 4	558.7	PHYSICAL EXERCISE Q3 (583) GREENHOUSE Q2 Partial credit (568)	At Level 4, students can work effectively with situations and issues that may involve explicit phenomena requiring them to make inferences about the role of science or technology. They can select and integrate explanations from different disciplines of science or technology and link those explanations directly to aspects of life situations. Students at this level can reflect on their actions and they can communicate decisions using scientific knowledge and evidence.
Level 3	484.1	PHYSICAL EXERCISE Q1 (545) GREENHOUSE Q1 (529) ACID RAIN Q3 Partial credit (513) ACID RAIN Q1 (506)	At Level 3, students can identify clearly described scientific issues in a range of contexts. They can select facts and knowledge to explain phenomena and apply simple models or inquiry strategies. Students at this level can interpret and use scientific concepts from different disciplines and can apply them directly. They can develop short statements using facts and make decisions based on scientific knowledge.
Level 2	409.5	ACID RAIN Q2 (460)	At Level 2, students have adequate scientific knowledge to provide possible explanations in familiar contexts or draw conclusions based on simple investigations. They are capable of direct reasoning and making literal interpretations of the results of scientific inquiry or technological problem solving.
Level 1	334.9	PHYSICAL EXERCISE Q2 (386)	At Level 1, students have such a limited scientific knowledge that it can only be applied to a few, familiar situations. They can present scientific explanations that are obvious and follow explicitly from given evidence.

REPORTING PROFICIENCY IN SCIENCE

PISA results are reported on a scale constructed using a generalised form of the Rasch model as described by Adams, Wilson and Wang (1997). For each domain (reading, mathematics and science), a scale is constructed with a mean score of 500 and standard deviation of 100 among OECD countries; accordingly, about two-thirds of students across OECD countries score between 400 and 600 points.

When science was the major assessment domain for the first time in 2006, six proficiency levels were defined on the science scale. These same proficiency levels will be used in the reporting of science results for PISA 2009. Proficiency at each of the six levels can be understood in relation to the kinds of scientific competencies that a student needs to attain at each level. Figure 3.10 presents a description of the scientific knowledge and skills which students possess at the various proficiency levels, with Level 6 being the highest level of proficiency. It also gives the level and scale score of each item belonging to the three units from the PISA 2006 assessment, which are used as examples throughout this chapter.

e capacity of students who performed below Level 1 in PISA 2006 (about 5.2% of students on average across OECD countries) could not be reliably described because not enough science items were located in this region of the scale. Level 2 was established as the baseline level of *scientific literacy*, defining the level of achievement on the PISA scale at which students begin to demonstrate the scientific knowledge and skills that will enable them to participate actively in life situations related to science and technology.

Factors that determine difficulty of items assessing science achievement include:

- The general complexity of the context.
- The level of familiarity of the scientific ideas, processes and terminology involved.
- The length of the train of logic required to respond to a question – that is, the number of steps needed to arrive at an adequate response and the level of dependence of each step on the previous one.
- The degree to which abstract scientific ideas or concepts are required in forming a response.
- The level of reasoning, insight and generalisation involved in forming judgements, conclusions and explanations.

Question 3 of *GREENHOUSE* (Science example 2) is an example of a difficult item, located at Level 6 on the PISA science scale. This question combines aspects of the two competencies, identifying scientific issues and explaining phenomena scientifically. As a first step to solving this problem, the student must be able to identify the change and measured variables and have sufficient understanding of the methods of investigation to recognise the influence of other factors. In addition, the student needs to recognise the scenario and identify its major components. This involves identifying a number of abstract concepts and their relationships in order to determine what "other" factors might affect the relationship between Earth's temperature and the amount of carbon dioxide emissions in the atmosphere. Thus, in order to respond correctly, a student must understand the need to control factors outside the changed and measured variables and must possess sufficient knowledge of "Earth systems" to identify at least one of the factors that should be controlled. Sufficient knowledge of "Earth systems" is considered the critical scientific skill involved, so this question is categorised as explaining phenomena scientifically.

Question 1 of *PHYSICAL EXERCISE* (Science example 3) is an example of an easy item, located at Level 1 on the PISA science scale below the baseline of scientific literacy. To gain credit, a student must correctly recall knowledge about the operation of muscles and formation of fat in the body, particularly the facts that when muscles are exercised they get an increased flow of blood and fats are not formed. This knowledge enables the student to accept the first statement of this complex multiple-choice question and reject the second one. In this item, no context needs to be analysed – the knowledge required has widespread currency and no relationships need investigating or establishing.

PISA 2006 results were also reported on three subscales corresponding to the three scientific competencies. These subscales used the same six proficiency levels as the combined scale, but with descriptors unique to each scale. In addition, country performance was compared on the bases of knowledge *about* science and the three main knowledge *of* science categories (Physical systems, Living systems, and Earth and space systems).

While the analyses drawn from these kinds of comparisons could be valuable, caution should be used when relating performance to competencies and knowledge because the data come from classifying the same items in

two ways that are not independent. All items classified as assessing the identifying scientific issues competency are knowledge about science items, and all explaining phenomena scientifically items are knowledge of science items (OECD, 2009, p. 44).

CONCLUSION

The PISA definition of *scientific literacy* originates in the consideration of what 15-year-old students should know, value and be able to do as preparation for life in modern society. Central to the definition, and the science assessment, are the competencies that are characteristic of science and scientific enquiry: *identifying scientific issues, explaining phenomena scientifically*, and *using scientific evidence*. The ability of students to perform these competencies depends on their scientific knowledge, both knowledge of the natural world (*i.e.* knowledge of, chemistry, biology, Earth and space sciences, and technology) and knowledge about science itself (*i.e.* knowledge about scientific enquiry and scientific explanations), and their attitudes towards science-related issues.

This framework describes and illustrates the scientific competencies, knowledge and attitudes involved in the PISA definition of *scientific literacy* (see Figure 3.11), and outlines the format and structure of the PISA 2009 science assessment.

Figure 3.11 ■ **Major components of the PISA definition of scientific literacy**

Competencies	Knowledge	Attitudes
■ Identifying scientific issues ■ Explaining scientific phenomena ■ Using scientific evidence	■ Knowledge *of* science: *Physical systems* *Living systems* *Earth and space systems* *Technology systems* ■ Knowledge *about* science: *Scientific enquiry* *Scientific explanations*	■ Interest in science ■ Support for scientific enquiry ■ Responsibility towards resources and environment

PISA science test items are grouped into units with each unit beginning with stimulus material that establishes the context for its items. The focus is on situations in which applications of science have particular value in improving the quality of life of individuals and communities. A combination of multiple-choice and constructed-response item types is used and some items involve partial credit scoring. Unlike PISA 2006, attitudinal items are not included in units in PISA 2009.

PISA 2009 science results will be reported on a single science scale having a mean of 500 and a standard deviation of 100, using the six levels of proficiency defined when science was the major assessment domain for the first time in 2006. Level 6 is the highest level of proficiency and Level 2 has been established as the baseline level of *scientific literacy*. Students achieving below Level 2 do not demonstrate the scientific knowledge and skills that will enable them to participate actively in life situations related to science and technology.

Notes

1. Throughout this framework, natural world includes the changes made by human activity, including the material world designed and shaped by technologies.

2. Knowledge of the design or internal working of technology artefacts (*e.g.* aeroplanes, engines, computers) will not be assumed.

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4

PISA 2009 Questionnaire Framework

This chapter describes the framework that led the design of the PISA 2009 questionnaires; the aim was to gather policy-relevant background information linked to student achievement from school principals, students and parents.

The chapter presents the types and purposes of the information collected at four different levels: the educational system as a whole; the school level; the instructional setting; and the student level. It also puts forward ideas for analysing the policy-relevance of the data collected, such as: investigating effective learning environments in reading; ensuring school effectiveness and management; promoting educational equity and cost effectiveness; and developing system-level indicators.

INTRODUCTION

Although PISA is probably best known for measuring and reporting the achievement of 15-year-olds in reading, mathematics, and science in a wide range of countries, it also serves a larger purpose for interpreting test results and assessing educational policies through its collection of background information. This chapter presents and discusses the purpose and usefulness of the Questionnaire Framework, which is used to gather the background information addressing policy issues linked to student achievement.

Clearly, interest in the academic performance of students is not limited to descriptions of performance levels and differences within and among countries. Reading the achievement results leads to questions such as: Why do 15-year-olds in some countries perform better than those in others? Why are some students high performers, many others average, and some low performers? Can these differences be explained by differences in societal characteristics, families, school resources, instructional practices, and communities? Being policy driven, not only must PISA provide policy makers with descriptions of the results, but also with the information and capacity to improve them. The test results alone cannot provide answers to these questions. Therefore, PISA's goal is to gather additional data that will enable policy makers to draw inferences about the patterns of achievement results and why they occur.

How can the additional data from questionnaires be used to interpret achievement differences? Their most important contribution is that they enrich the analysis by describing the characteristics of families and the organisation of education systems at different levels from the national level through to the classroom and home. PISA sets out to relate educational achievement to these characteristics in order to identify general patterns among countries and specific patterns within countries. Given that the PISA 2009 results can be compared with those of the earlier studies, (PISA 2000, PISA 2003 and PISA 2006) PISA can not only compare the trends in achievement over almost a decade for many countries, but also attempt to relate those trends to changes in policies, practices, and student populations.

PISA provides the possibility to speculate about the change in achievement outcomes. PISA is speculative because it is what is known as a yield study that attempts to ascertain the cumulative achievement of students towards the end of compulsory education. In other words, PISA is not an attempt to ascertain how much learning has taken place in the secondary school in which a student is enrolled. This would require comparing the achievement of students at entry into their present school to their achievement at that same school at age 15. This would provide a measure of progress or value-added in achievement associated with educational experiences in that particular school. PISA only tests the students once at age 15. A further challenge is the relatively short period of time that students in many countries have attended their present secondary schools, typically three years or less for most students. Therefore, only a portion of their level of achievement is due to educational characteristics of their present school and classroom, while some is due to previous educational experiences that may not be reflected in data from the present school.

In essence, PISA makes it possible to find patterns of statistical association between achievement, on the one hand, and family, school, and other educational influences, on the other. Some of these patterns will be strong and relatively consistent among countries, and those are most likely to tell an underlying story that may initiate a search for causal mechanisms. Others will be weaker and inconsistent from country to country and may or may not have important policy implications. Interpretation for policy purposes must be sensitive to these differences. When the patterns of association are strong, there is also a basis for further investigation by countries to confirm whether such a phenomenon exists when more direct research is applied. Such focused research can involve intensive qualitative studies of families, schools, and classrooms, or it can employ statistical models to measure achievement gains through value-added studies or even experimental investigations that focus on associations found in PISA.

Educational policy is complex and is not easily encapsulated by a single definition. In general, educational policy addresses the actions that families, government bodies, and other educational organisations take to shape and operate educational systems at all levels of education and all levels of government. Clearly, educational policy embraces the actions of many entities including those who occupy positions of educational leadership such as ministers and secretaries of education, those who make laws, technical staff who make operative and concrete decisions, and administrators and teachers who must implement specific educational actions. In addition, educational policy may include the activities of families through mandates or guidelines that influence their behaviour.

> In terms of some of the general uses of the results, policy makers are using PISA findings to gauge the knowledge and skills of students in their own country in comparison with those of the other participating countries; establish benchmarks for education improvement, for example, in terms of the mean scores achieved by other countries or their capacity to provide high levels of equity in educational outcomes and opportunities; and understand relative strengths and weaknesses of their education systems. (OECD, 2007)

Good educational policy is informed educational policy in which all of the responsible actors (policy makers, school principals, teachers, students and parents), are provided with the knowledge that they need to make good educational decisions. Although the test results from PISA may inform and motivate these actors to seek ways of improving the levels and equality of educational performance, they need considerable further information that will assist them in formulating strategies to achieve those ends.

For this reason PISA has made a concerted effort to gather background information on educational systems, schools, families, and students that might inform the potential sources of differences in achievement, both within and among countries, and that might be used to formulate strategies for improvement of overall academic performance and educational equity.

Choosing and collecting the types of specific background information on families, students, and schools that might be linked to achievement is a daunting task. The reason is that there are many possible types of information that can be sought, especially those which may be pertinent in some countries and regional settings, but not in others. Further, there is the constraint on time of those who are asked to provide the information, where most of the specific information on schools and classrooms must be obtained from individual students and principals through survey questionnaires. In order to safeguard the time requested of both groups of informants and to increase the reliability of the information and the completeness of responses, it is important to limit the typical time required of respondents to provide questionnaire information. Principals are usually very busy, so it is essential to ask them for information on key questions that help to understand school policies and operations. Students will not only be asked to fill out background information on their families and school experiences, but will also take PISA tests in the subject areas - a taxing demand on time and effort. To gather background information, only about 30 minutes can be allotted to the questions asked of students on their personal background, their learning habits, characteristics of their school and classrooms, and their attitudes to learning as well as their engagement and motivation. This is in addition to two hours devoted to the testing in the three subject areas.

It is well known that as the length and difficulty of a questionnaire increase, the accuracy of responses tends to decrease, and it is increasingly likely that some questions will be skipped completely. Accordingly, the goal of designing surveys to obtain useful interpretive information is to prioritise the information sought and to obtain it accurately, subject to the time constraint for questionnaires set by the PISA Governing Board. The section below describes the strategy for reaching this goal.

TYPES OF BACKGROUND INFORMATION AND THEIR PURPOSES

The types of background information collected on the questionnaires are purpose-driven in that they aim to provide interpretive frameworks and data for analysing PISA results. The challenge of collecting such information is complicated by the fact that educational systems have many actors at different levels. For most systems there is a national or federal entity that sets country policy and is instrumental in allocating resources. Many countries also sponsor regional agencies that are partially accountable for these functions. Some schools are embedded in districts that monitor and enforce policies as well as distribute and contribute to school resources. It is possible to consider this level as the educational system as a whole, which describes the overall national or federal system and its supporting and regulatory elements for governing and providing education. In some countries the system is highly centralised under a ministry with ultimate authority, and in other countries the national responsibility for education is decentralised through shared responsibilities at different levels of government. However the overall system is organised, it ultimately must interact and support the key learning organisational site: the school.

It is at the school level where the educational system interacts directly with communities, parents, and children. At school the students receive their formal educational experience. Individual schools are responsible for educating all children efficiently and meeting the goals and educational requirements set by higher levels of governance. They must recruit personnel and acquire the materials that will enable the educational process to proceed. In addition, they

must respond to national and regional systems of accountability for educational results in terms of accommodating student enrolments and producing achievement and ultimate educational attainments. They encompass what is known as the educational core, where the teaching and learning takes place, and they must be organised to do that effectively. School policies are central to this mission in terms of the time that is devoted to learning, including the length of the school day and school year, the organisation of the curriculum, teacher selection, retention and professional development, parental involvement, school leadership, and the internal allocation of resources.

Schools are organised into subunits of grade levels and classrooms. Although the overall school environment and practices clearly have an impact on a child's education, the most intensive educational experiences take place within his or her grade level in classrooms. Within the school, learning objectives and practices must be articulated among grade levels so that the requirements for success at higher grades are satisfied by learning at the preceding grade levels. Regardless of the educational requirements set by nations, regions, and schools, these must be translated into specific practices which often differ in significant ways in application from teacher to teacher and classroom to classroom. In recent decades educators have recognised that it is not only the guiding policies which determine the quality and depth of instruction and its focus, but also the implementation of those principles. Research studies have found remarkable variance both among and within schools that are governed under the same regulations and overall decisions on practice (Fullan, 2007). It is therefore important to understand the classroom practices employed by teachers in such instructional settings, as well as their beliefs, attitudes, skills, and training experiences to establish links with student achievement.

The first round of the new OECD Teaching and Learning International Survey (TALIS; OECD, 2009), focused on policies and practices that shape the teaching and learning environment in schools, providing policy-relevant insights on teachers' professional development, appraisal and feedback to teachers, teaching beliefs and classroom practices and school leadership. In future cycles of PISA and TALIS, a potential linkage of the two programmes on the school level could lead to analytical gains in a country. First, the student background and student performance information from PISA would provide an important context for analysing and better understanding the teacher responses in TALIS (*e.g.* understanding the extent to which teachers' professional development needs being met vary between high and low performing schools or schools facing more or less challenging circumstances). Second, teacher information, such as that collected through TALIS, could improve the measurement of the instructional environment in schools and enhance the explanatory power within PISA both in terms of school performance and the attitudes of students.

Finally, the level which is perhaps the most complex of all is the student level. National and regional entities set goals, institutional arrangements, financing, and licensing requirements for educational personnel. Schools operate within these parameters to create learning organisations. Most implementation of learning takes place within instructional units within the school, typically classrooms. But, learning takes place because all of these arrangements create opportunities, incentives, and expectations for individual students and student groups to learn. What is reflected in the achievement measures is the product of how these specific provisions operate to enable students to succeed. Therefore at the individual student level, it is important to document the student backgrounds, student expectations and attitudes, available resources and practices that affect educational outcomes.

Knowing a student's educational experiences in the school or classroom is not adequate for understanding all student influences on learning. Fifteen-year-old students have spent the vast majority of their waking hours outside of school. This means that differences in home and community environments such as parental educational resources in the home and other learning opportunities are crucial determinants of student learning and achievement. Furthermore, family influences are likely to affect student motivations and attitudes towards learning overall and in specific subjects and can have profound effects on performance, particularly in reading. Since most out-of-school learning depends on parental and community resources, such background information is crucial in interpreting achievement patterns as well as students' capacity and attitudes towards learning.

What is described here is a constellation of institutions and actors at different levels that constitute an educational system. The interactions among these are complex and not fully understood, yet each level is important in shaping educational policy and probable education outcomes. The principal challenge of obtaining useful background information to help interpret achievement results and relate these to educational policy is determining the types and form of information to be collected and how to relate it to student achievement in what appears to be a swamp of complexity. To add to the challenge, most of the information must be collected directly from principals and students in a highly time-constrained setting where their time is precious and for which only very limited demands can be made.

The strategy is to begin with some of the major relevant questions at each level of the educational system and to use those questions to focus on important data categories that are central to the later analysis of achievement. These must be translated into specific questions that appear on the questionnaires, or for which answers are available from other sources, and that the respondents understand so that accurate answers will be provided within time constraints. Since this process begins with some overall policy questions and some knowledge of the general literature that establishes relationships between this information and student achievement, it is important to establish the required types of information at each of the four levels of the system. The four levels are:

- educational system as a whole
- school level
- instructional settings
- individual student level

Educational system as a whole

The purpose of information at the highest level is to provide comparative descriptions of educational systems and to allow for the exploration of a large range of educational outcomes as they relate to the overall conditions that characterise the educational system. Examples of descriptive information include:

- measures of wealth and income of the country and region
- overall status of teachers
- community involvement in schooling
- level of decision-making
- public versus private schools
- measures of societal inequality
- forms of accountability

What is unique about this list of information is that much of it can be obtained from sources other than questionnaires because it is available as administrative data from the countries themselves as well as international organisations such as the OECD, UNESCO and the World Bank (OECD, 2008; UNESCO, 2005; World Bank, 2008).

Each category of information is related to social science studies that show a relation between student achievement and the information category. For example, studies of educational achievement among societies find that both within and among nations the amount of per-capita income is a strong predictor of student achievement (Baker, Goesling & Letendre, 2002). The overall status of teachers is important because it affects the attractiveness of the teaching profession (Darling-Hammond, 1997). Active community and parental involvement in schooling has been linked to student educational outcomes (Ho & Willms, 1996). Measures of societal inequality are linked to educational inequality in terms of family resources and learning conditions (Rothstein, 2004). And, the measurement, visibility, and sanctioning of student and school success are believed to provide inducements to better performance (Hanushek & Raymond, 2004).

These are antecedents of educational policy, operations, and outcomes in the sense that they exist in a larger societal context which may affect educational results. For example, measures such as Gross Domestic Product (GDP) per capita reflect family resources that influence education as well as societal investments in education. Heterogeneity of the population through immigrants, and particularly immigrants from other language, cultural, and economic backgrounds, will determine the educational challenges in classrooms as well as the preparedness of students to succeed in a mainstream environment that may differ significantly from that of their population subgroups. Community involvement in schooling can provide greater effectiveness through educational adaptation to the needs of local populations. Throughout the world many countries are establishing different approaches to decentralising decision-making, differences that might have a bearing on educational achievement in terms of the level of the educational system where such matters as curriculum, teacher salaries, and student policies are established. Although the centralisation versus decentralisation of decision-making will be addressed more fully when its impact at the school level is discussed, it is important to note that the authority to make decisions at each level is usually established by national, federal or regional governments, and schools are expected to follow these laws, regulations, and conventions.

Another form of decentralisation is the degree to which non-government schools are relied upon to provide education. The use of a market of choice among non-governmental (private or independent schools) is an important form of decentralisation of decision-making. Although such schools exist within a government regulatory framework, they generally have considerably more freedom than public schools to make educational decisions. Indeed, in some countries the private schools are fully funded from government sources (government-dependent private schools) and must meet certain government standards (James, 1984). Since families can choose among such schools, they also express their preferences, a particularly strong form of involvement in educational decisions. Choice among public and private schools (whether independent or government-dependent) is championed as a mechanism to create incentives for schools to compete for students and improve the overall performance of the educational system (UNESCO, 2005). By providing background information on the organisation of schools, it is hoped to gain insights into the impact of alternative structural arrangements on achievement. Accountability systems are another focus of educational systems in most countries where the attempt is to put in place systems of school and student assessment that will ensure that students meet important educational standards (Carnoy, Elmore & Siskin, 2003). In some countries the passing of examinations at the end of courses or end of the school year are required to move to the next level of study. In other cases, tests are given to establish how well individual students and schools are learning, but the results are simply used to provide evaluation information without individual consequences. Examination policies also differ with respect to whether the tests are developed by classroom teachers and schools for their own students or by regional, federal or national authorities. That is, some examinations are internal to the school and focus on classroom or school objectives, and others are external where the national, federal or regional authorities set a standard. Different forms of examination may have different consequences for providing incentives to learn, uniformity of what is taught, and educational results.

Specific patterns of educational investment among regions, schools, and students may have important consequences as well. In some countries policy provides for similar funding per student for all students, regardless of the economic circumstances of their families. In others there are additional resources for students from rural, impoverished or immigrant backgrounds or for those with learning or physical difficulties. How spending is allocated may have implications for both the level of achievement as well as equity in achievement outcomes.

Overall, information on the educational system as a whole can provide a picture of how the overall resources and practices of a society impact educational achievement. For example, to what degree do differences in the overall wealth of a society and its distribution affect the level and distribution of achievement? Do the impacts differ by subject and population group such as natives and immigrants? To what degree does the schooling system serve to equalise educational outcomes, and to what degree do the outcomes simply reflect existing inequalities. How attractive is the teaching profession relative to other professions in the country, and how does this affect the ability to maintain a quality teaching force? How does the organisation of schools, school decision-making and investment policies among different groups of students and regions affect educational results? All of these are questions that can only be addressed if background information is available that supplements the data on achievement.

Table 4.1 **Examples of data items for educational system as a whole**

Title	Description/measure
Measures of wealth and income of country and region	Gross domestic product per capita
Overall status of teachers	Teacher salaries and benefits relative to other occupations with similar education
Community involvement in schooling	Extent of influence of parents and school governing board on decision-making
Level of decision-making	Government levels or constituencies that influence directly decisions in staffing, budgeting, instructional content, and assessment practices
Public versus private schools	Is school public or private?
Measures of social inequality	Summary measures of income distribution
Forms of accountability	Are achievement data used to monitor accountability?

(OECD, 2008; UNESCO, 2005; The World Bank, 2008)

School level

As emphasised earlier, the organisation of schools is complex and varies considerably, not only from country to country, but also among internal educational sub-divisions such as federal states or provinces, regions, school districts, and individual schools. PISA aims to identify the types of differences that are most likely to impact student achievement and selects the differences to be measured in a limited time frame for questionnaire administration.

Since PISA is concerned with relating school characteristics to their probable efficacy in improving student achievement, in most cases measures of actual school operations are sought rather than the formal policies under which they are supposed to operate. In recent decades it has become widely recognised that the formal descriptions of educational operations in schools are often misleading because implementation differs so widely (Fullan & Stiegelbauer, 1991; Fullan, 1992). Implementation refers to the actual application of schooling procedures, and researchers have found that under the same descriptive rubrics the actual behaviour can differ markedly. This means that official lists of educational goals, requirements, and procedures are not adequate to describe the operational behaviour of schools and must be supplemented by information from the respondents on the actual ways in which their schools operate. Accordingly, the questionnaire surveys attempt to obtain information directly on operations from the participants, and especially the school principal.

Within this context, some of the main categories in which PISA 2009 attempts to gather background information on schools are:

- school leadership
- composition of student enrolments
- curricular emphasis
- extra-curricular activities
- school size
- support for teaching and learning

School leadership is a particularly important variable that might be altered by policy in directions that support learning. Some success has been found in research on this issue where attempts have been made to measure principals' activities in key dimensions of a school's instructional programme and to relate these to student outcomes such as reading achievement (Hallinger, Bickman & Davis, 1996). The goal is to obtain information

on principals who are devoted to and active in attending to those dimensions that seem effective in improving student learning.

Furthermore, it is worthwhile to ascertain whether the important dimensions of school leadership that affect achievement are relatively universal in nature or differ according to educational system and type of student. This is relatively new research in the educational policy area, but establishing an international database is the first step in using it.

A related component of school leadership is imposed on the school by the degree of decentralisation of decision-making set out for schools. In recent years there has been considerable focus on school autonomy as a way of overcoming bureaucratic rigidity and potentially having an impact on learning outcomes (Bottani & Favre, 2001; Chubb & Moe, 1990). In some societies the hiring of teachers, establishing curriculum, and assessing students is carried out at a central level where the school is merely expected to follow the directions set out for school routine operations. At the opposite end of the spectrum the school is largely autonomous and expected to choose its own teachers, to influence teacher compensation, to choose curriculum and undertake its own academic assessment of students. Of course, when school is referred to in this sense, it is not only referring to the head administrators at school sites, but also to the roles that teachers, parents, and students might play in educational decision-making. Whether decisions should be centralised or decentralised and which ones should be placed at different levels is still a subject for debate. However, by getting measures of centralisation and decentralisation for different functions, it may be possible to ascertain the impact of such policies on achievement.

The type of student body is likely to have an impact on educational achievement. Not only does the individual socio-economic status of students have an impact on the performance of individual students, but also the overall socio-economic composition of school enrolments. Schools with students of higher socio-economic status tend to create an overall school environment of high aspirations and support for academic learning which provides advantages for all students, regardless of high or low socio-economic status, who are enrolled in those schools. This is known as a compositional or peer effect. But, even beyond the matter of how student composition affects individual students, such schools may attract better teachers, those who seek school environments where they will experience success in student learning. Furthermore, teachers in schools with higher socio-economic enrolments know that the overall academic level of performance is higher and are likely to respond by setting a faster pace for the curriculum and higher performance expectations for all students. For these reasons it is important to assess the overall socio-economic composition of students to explore its impact on achievement (Zimmer & Toma, 2000).

A somewhat different dimension of the student body is the proportion of immigrants and their origins. In general, immigrants face a number of disadvantages such as having a mother tongue different from the official language of the school and the resident society. In addition, they often have to adjust to an unfamiliar cultural context and they may face discrimination. Immigrants who have emigrated from low income countries, where educational opportunities are slim and standards low, face a particularly harsh educational challenge. When a relatively high proportion of school enrolment is comprised of children of immigrants, the overall learning environment of the school may be challenged for all students by a slower curriculum pace, language deficiencies of fellow students, and differential educational aspirations. Therefore not only is it important to take into account the socio-economic composition of student enrolments, but also the concentration of immigrant students and especially those from countries with low income and poor educational opportunities.

Two other conditions that may have an impact on determining the supportive nature of the school environment are the affluence of the surrounding community and the degree of parental involvement. Affluent communities tend to have more positive educational influences and support systems in comparison to poorer communities. First, they tend to be safer with less crime and violence. They are therefore less preoccupied than poor communities with the possible effects of crime and violence on students. Second, such neighbourhoods have more resources to support schools in informal ways through volunteering and the occasional provision of extra resources that may be needed. Reciprocally, good schools reflect on the quality of neighbourhoods, setting out incentives for neighbourhoods to assist in their maintenance and support.

Parental involvement has an even more direct effect on student achievement (Epstein, 2001). When schools encourage and make a provision for parental involvement, parents can become more effective in supporting both school programmes and the educational progress of their own children. Furthermore, parents who participate in

school activities are more likely to volunteer their efforts in assisting the school, therefore increasing available resources. Once parents are involved in addressing the needs of a school, they may also seek other ways to assist the school in acquiring resources and assisting those children in academic need. Parents who know what schools expect through familiarity with the school programme and teacher expectations are better able to assist their own children in learning. In some schools, parental involvement can take the form of teaching parents the skills that they need to support their children's learning.

Finally, the act of attracting parents to participate actively in educational and school endeavours can serve to form social networks where parents get to know and help each other. That is, parents become a community of resources that can assist each other to address a wider range of child and family needs, a resource that is particularly important for those who would otherwise be isolated and with fewer resources to draw upon. It has been argued that such social networks built around schools raise overall achievement through the accumulation of what is known as social capital (Coleman, 1988).

Beyond what happens in the classroom, schools as a whole can also put curricular emphasis on particular subjects such as reading. Some schools require all teachers at each grade level to devote a certain amount of time to both the teaching of reading and the allocation of reading as part of assignments and school activities. Others even schedule independent reading time during the school day or coordinate school work with library resources and services. The prevalence of other literacy activities such as writing, listening, and requiring oral presentations also reinforces reading skills. Clearly it is expected that more time would be devoted to reading assignments and literacy activities to contribute to reading proficiencies. The same is true with regard to an emphasis on critical reading skills that require more sophisticated comprehension and understanding of written materials. When the curriculum approach requires critical analysis of readings through questioning a point of view, understanding the different sides of an argument and the evidence supporting each side, analysing the literary styles and meaning, and other deeper approaches to meaning in reading, the student is exposed to a richer understanding of written material and thought. Above all it is not only the specific amount of reading and assessment of narrow components of reading that constitute differences in school curriculum, but also the emphasis placed on preparing students for a wide array of literacy tasks such as writing, debating, problem-solving, and discussion. New demands are also set by media. Proficiency in reading is not limited to printed text but also to the texts in the electronic media, which are becoming a more important part of student life and societal communication in general. PISA 2009 has included an assessment of literacy in the reading of electronic texts in addition to printed texts (see Chapter 1).

On a broader level, the variety and quality of extra-curricular activities can also contribute to reading proficiencies. Some extra-curricular opportunities depend intrinsically on reading and literacy such as drama and theatre, journalism, creative writing, the school newspaper and professional clubs such as those devoted to science, history, communication technologies or a foreign language and culture. To the degree that these require reading activities as part of the extra-curricular offerings, reading ability should be enhanced as a by-product.

School size is viewed widely as having some relation to achievement, although the overall relationship is not clear. With larger enrolments, schools can offer their students a greater variety of courses and electives as well as extra-curricular activities. This means that individual students have more options when choosing courses and also, possibly, a greater choice of teachers for particular subjects. By increasing the possibility of electing more courses of their choice, students can select those that are most meaningful to them educationally and for which they are most motivated.

But, larger schools also tend to be more impersonal where students may not feel supported as much by teachers and other personnel. Research has found that smaller high schools demonstrate a greater and more equitable distribution of student engagement and achievement among 15-year-olds (Lee & Smith, 1995). Thus, the size relation goes in both directions, and there is no overall consensus in the literature on where the balance lies. In fact, some research suggests that size affects different groups of students (*e.g.* socio-economic groups) differentially, so the best size policy depends upon the characteristics of the students (Lee & Smith, 1997).

Finally, a highly supportive teaching and learning environment at the school level enhances the teaching and learning of all subjects. Studies of effective schools find that an academic focus on school culture is positively related to student achievement. In such an environment it is clear what is valued by both teachers and students. Academic activities and student academic performance are considered to be a central feature of a successful school. This literature has also identified a range of other features of schools that are associated with greater success on academic measures (Scheerens & Bosker, 1997; Sammons, 1999; Taylor, Pressley & Pearson, 2002).

Table 4.2 **Examples of data items for school level (see Annex B)**

Title	Description
School leadership	Principal's activities and behaviours
Composition of student enrolments	Percentage of students whose first language is not the test language
Curricular emphasis	Time spent in school on specific subjects
Extra-curricular activities	Inventory of school activities offered to students
School size	Total school enrolment
Support for teaching and learning	Principal's activities and behaviours on teaching and instruction

These school features are important dimensions of the overall learning environment that have been linked to student achievement generally and reading achievement specifically. Each has been refined into specific questions which are used in the questionnaire of the school principal. With the aim of obtaining high quality data on schools, it is hoped that a range of school policies can be reviewed in many countries to ascertain their potential links to student reading achievement in PISA 2009. But, within the school it is the instructional setting in which the most intensive teaching and learning activities take place.

Instructional Settings

There are two principal instructional settings: the home and the classroom. Obviously the home is an instructional setting where parents provide opportunities in the broader language area by interacting with their children, and in a narrower sense by promoting literacy and reading skills and reading and discussion opportunities. Often the availability of reading materials in the home or the use of public libraries is included as an indicator of support for the opportunity to read outside of school. But, governments typically have less policy leverage over family activities that promote reading.

The more prominent instructional setting over which governments and educators have policy discretion is the school. Although students can be viewed as having received their schooling in a particular school, most of a student's educational experiences at school occur in the classroom. In the classroom the student has been exposed to subject content, curriculum materials, and instructional strategies of specific teachers. Typically, each teacher is specialised by subject area at the secondary level and focused on teaching courses in their specialised areas of the curriculum. Given that so much time is spent in the classroom and the experience is intense, it is likely that the strongest influences of a school on a student's experiences and achievement could be found in this smaller instructional setting. It is therefore important to document the characteristics of teaching and learning and the interactions that take place within the classroom. This section identifies some of the characteristics of the instructional setting that are believed to influence achievement.

Some principal categories in which PISA 2009 has attempted to obtain information on instructional settings include:

- class size
- composition of class enrolments
- teacher quality
- opportunity to learn
- orderliness of classroom environment
- supportive teaching and learning conditions

Although there are many dimensions of instructional settings that may affect educational outcomes, the most important features are usually thought of as the classroom context, the teacher, the curriculum, and instructional strategies. The classroom context refers to the size of classes and instructional groupings as well

as the characteristics of fellow students. It could also extend to the suitability and condition of the physical environment of the classroom. The teacher is characterised by: education and training; teaching experience; pedagogical and subject knowledge and skills; and attitudes towards students, subjects, and instructional approaches. The curriculum refers to the content of the subject that is taught as well as the supportive materials. Instructional approaches refer to methods of pedagogy such as the balance that teachers establish between: teacher lectures and whole group instruction; individual student practice and reinforcement; group activities; and independent projects.

Previous research has found that the complexity of each of these areas limits the comprehensiveness and accuracy of information obtained by any single data collection strategy. Information by survey questionnaires is further reduced by the time constraints imposed by PISA to avoid excessive time demands on respondents. More detailed information would require long individual classroom observations as well as interpretive interviews with teachers and students: techniques that are costly and time-consuming and beyond the resources available. Nevertheless, considerable valuable information that appears to be linked to student achievement can be obtained through PISA's principal and student surveys. Furthermore, it is possible for individual countries to do more intensive studies of classrooms and schools when merited by strong findings from PISA (LeCompte, 1999; Creswell, 2009).

One of the most common measures of academic quality believed to affect student achievement is the size of the class. Parents prefer their children to be placed in small classes, and class size is widely used to assess the quality of a school. Logically, if a teacher has fewer students in the class, more time can be devoted to the educational needs of each student. Furthermore, fewer students mean fewer assignments to evaluate, so a teacher can provide more feedback and assign richer activities and assessments. Smaller classes also enable greater opportunities to participate in class. Teachers can call on more students within a given time period, and students are more likely to be called upon when they offer to respond to questions. If teachers adapt their instruction from teacher lectures to more participative forms of instructions with students, they might get further gains from smaller classes than from maintaining traditional instruction approaches used with larger groups of students. This illustrates the difficulties of separating out the distinct effects of class size from those of instructional approaches.

An important feature of the classroom context is the composition of students in the class. At least two dimensions are significant, the socio-economic and immigrant composition and the levels of ability. The concern about the socio-economic and immigrant composition of students at the classroom level is similar to that at the school level in terms of its impact on learning. When a class has a greater proportion of students from more advantaged families and with fewer immigrants, especially those from lower-income countries where the mother tongue differs from the instructional language, there are positive contextual impacts on achievement that even help the few immigrant or lower socio-economic students in the class. The best teachers often seek these teaching opportunities and set high expectations and a more demanding curriculum with deeper focus and richer content to meet the perception of highly capable students, providing positive academic advantages for all students in the class. In a class with higher proportions of immigrants and students from lower socio-economic backgrounds, teachers adjust expectations and curriculum challenge downward, often in subtle ways. At the same time, there are peer interactions among students through shared ideas, vocabulary and aspirations that influence each other.

However, one could question why the peer composition of a classroom should differ from peer composition of the school as a whole. This applies to schools at all levels of the socio-economic spectrum. Therefore it might seem that schools with a student composition that is largely lower socio-economic in nature might have similar student composition in its classes. But, schools follow different policies with respect to the assignment of students to classes. Some schools stream or track students into classes with other students of similar background and academic performance. In those cases, the school sorts students into classes of different academic ability or native language proficiency - usually a measure of achievement rather than innate ability or immigrant status. Although the rationale is to enable each teacher to improve instruction by tailoring it specifically to student ability, there is considerable evidence that the educational impact of such grouping may widen the gap in achievement among such groups (Oakes, 2005; Gamoran, 1992).

A central concern in explaining differences in student achievement is the quality of the teacher (Wayne & Youngs, 2003). The most obvious characteristics that are assumed to determine teacher effectiveness are the quality and depth of their education, experience, and other teaching qualifications such as knowledge of subject matter and effective pedagogy, particularly as they contribute to proficiency among students. However,

the teacher's approach to instruction and attitudes towards their students and subject are also central. There are many other dimensions of classroom activity that are under the control of the teacher and can contribute to learning such as maximising the active learning time of students, using a variety of approaches, setting high expectations, and providing necessary support for different types of learners. These, and related aspects of teacher behaviour, are obtained through the student and principal questionnaires.

PISA 2009 also makes a special effort to ascertain the opportunity for students to learn. If they are given fewer opportunities to learn a subject, they are less likely to learn as much than if they were given more opportunities. There is therefore a focus on whether students have been exposed to different types of reading tasks and in different subjects. Student opportunity to improve reading depends not only on opportunities in the classroom, but also on those outside of school, and, especially, in the home. These types of opportunities are also likely to be influenced by the priority for reading development set by the school and imposed at the school level.

An orderly classroom environment has been identified as a key condition of learning in the many studies on effective schools. Such an environment is relatively free of disruption, has many predictable aspects in terms of activities and expectations, and is focused on student achievement.

Teaching and learning conditions with respect to reading are also central, though most of the knowledge base on this subject has been developed at the elementary school level. Because students are introduced to reading and reading development at the elementary level, the subject is often taken for granted at the secondary level as one that has already been accomplished. What this assumption ignores is that text at the secondary level is more complex and demanding with respect to achieving meaningful comprehension, and it is also more varied in its demands on the student from subject to subject. For example, reading skills for science, history, mathematics, and foreign languages may differ significantly in the structure of the material, the concepts that must be mastered, and the vocabulary.

To further complicate matters, there is not always agreement on whether reading is even a subject at the secondary school level or whether it is just part of all subjects, in which case many of the subject-matter teachers have not been trained to diagnose or focus on reading development. Accordingly, PISA 2009 has set out several dimensions to evaluate specifically the teaching and learning conditions in the instructional setting.

A different dimension of classroom learning is whether the instructional strategies take meta-cognition into account: the fact that individuals have different ways of learning, and pursue different subjects and tasks that call for different ways of learning (Baker & Brown, 1984; Flavell, 1979; Artelt, Schiefele & Schneider, 2001; see also Chapter 1). Meta-cognition or knowledge of one's usual or most appropriate learning strategies is not only helpful for students to learn efficiently, but appropriate for teachers to use in creating effective strategies for different groups of students according to their meta-cognitive processes. It is also believed that students can be oriented towards different approaches to meta-cognition that can broaden their own approaches to learning. When meta-cognition is taken account of, teachers and students consider the most appropriate learning strategies for achieving.

Other dimensions of the classroom that should be taken into account are the challenge of the learning environment and the modes and media that are used in activating students to undertake reading activities. Along with these are issues of monitoring and feedback with regard to providing teachers and students with information on how well students are performing academically and how to intervene to improve learning. Such feedback must be timely and sufficiently frequent so that both are informed and can continue or change strategies.

Table 4.3 **Examples of data items for instructional settings (see Annex B)**

Title	Description
Class size	Number of students in class of test subject
Composition of class enrolments	Aggregation of student reports on family background
Teacher quality	Teacher's instructional activities, as described by students
Opportunity to learn	Frequency of different reading activities
Orderliness of classroom environment	Frequency of disruption or disorder in class
Supportive teaching and learning conditions	Perceptions by student of teacher interest and support

Student level

Finally, PISA obtains information at the student level to ascertain individual differences among students that can account for differences in educational achievement.

Principal categories of information include:

- socio-economic background of students
- immigration status of students
- student learning styles
- student attitudes and reading activities

It is well-known that students of different socio-economic backgrounds enter schools with different levels of literacy and vary in their preparedness for learning to read and acquiring a high level of reading skills. Since PISA students are 15 years old, these socio-economic differences have had a historical impact reflected in different literacy levels at the time of school entry as well as in their influence on potentially differential rates of learning in the years prior to sitting the PISA test. More educated parents are able to provide a richer set of oral and written literary experiences which contribute to the education of their children both before their children begin school and during school. They are also able to provide more access to written materials for reading as well as travel and other resources that engage their child's curiosity. By the age of 15 it is not only the accumulated effects of schooling that contribute to their children's reading proficiencies, but also the experiences that take place in the home. One of the main purposes of gathering student data on family background is to take into account these influences on learning which are not attributable to the school.

Even so, it is often difficult to separate out the educational influence of family background from school variables for several reasons. Schools in different countries tend to be highly segregated by social class. That is, families of higher socio-economic origin typically select schools for their children that have better resources and educational reputation as well as a high concentration of peers with similar socio-economic backgrounds. In contrast, students of lower socio-economic origin are more typically found in schools with fewer educational resources and a high concentration of students with fewer socio-economic advantages. Since the characteristics of schools and those of families overlap substantially, it is difficult to separate their unique influences. And, to complicate matters there are often interactions between family and school resources that, in combination, have larger effects than when each is considered separately.

PISA attempts to collect extensive background data on students regarding socio-economic measures such as parents' occupations and education, home resources, immigration status, and reading engagement outside of school. This information is used to adjust for differences in achievement that may be due to opportunities outside of the school to attempt to more closely identify school and classroom outcomes. Student attitudes and

activities towards learning in general and reading in particular - how they use their opportunities and interest in reading and how they value the importance of reading - are important interpretive measures for assessing differences in reading achievement. It is not always known how to establish policies to alter these attitudes and reading activities, but with greater knowledge of which are important, it may be possible to consider approaches to alter student perspectives on learning and, consequently, to raise their level of achievement.

Table 4.4 **Examples of data items for student level (see Annex B)**

Title	Description
Socio-economic background of student	Highest levels of schooling completed by parents
Immigration status of student	Country of birth of student and parents
Student learning styles	Information on how student studies
Student attitudes and reading activities	Student preference and behaviour for specific reading activities

CONTENTS OF THE QUESTIONNAIRES

The extensive focus on the four levels of the educational system enables an informed search for statistical patterns that are linked to differences in achievement among countries, schools, classrooms, and individual students. But to reach this goal, the pertinent data that will inform these relationships is needed. PISA 2009 obtains appropriate background information through two questionnaires, one for schools (filled in by the principal or designate) and one for students. These two survey instruments are administered in all participating countries and economies. In addition, three survey questionnaires are provided as international options that countries can elect to have administered to enrich the information base for their schools and students.

- School questionnaire
- Student questionnaire
- Parent questionnaire (international option)
- Educational career questionnaire (international option)
- Questionnaire on student familiarity with ICT or information and communication technology (international option)

Annex B provides a complete list of the items of each questionnaire, but the purpose of this section is to present a brief summary of their contents.

It is important to note that most background items sought in the questionnaires were also used in previous PISA surveys, establishing continuity of data collection for comparison and the ability to search for trends over time. Additional items were created to explore new theoretical and policy dimensions of the achievement relationship, and the new items were subject to field testing to ensure that they were understandable to the respondent and measured the intended information goal. The field testing led to reconsideration and refinement of some of the new measures and omission of those that did not seem to serve their purpose.

School questionnaire

The respondent who is responsible for providing information on the school questionnaire is the school principal or designate, presumably the most knowledgeable person on school characteristics and functioning. This instrument was designed to take about 30 minutes to complete and is the key source of information on all dimensions of the school with additional information provided by students. Questionnaire items have been designed for transparency and to provide a format which simplifies its administration. It seeks to obtain a comprehensive picture with questions on the:

- structure and organisation of the school
- student and teacher body
- school's resources
- school's instruction, curriculum and assessment
- school climate
- school's policies and practices
- characteristics of the principal or designate

Student questionnaire

The student is responsible for providing the information in this questionnaire with an estimated 30 minutes for completion. Although obtaining more information in more detail from students would be desirable, the fact that they must also sit two hours of assessments is an important reason for limiting the length of the questionnaire. The specific categories of information that this questionnaire tries to assess are the student's:

- educational background
- family and home situation
- reading activities
- learning time
- school characteristics
- classroom and school climate
- language classes
- library access and activities
- strategies for reading and understanding texts

Parent questionnaire (international option)

This optional questionnaire is adopted by some countries and economies and delivered to parents by their 15-year-old child. The purpose is to gain considerable additional information on both parents and their children that could be used for more detailed and deeper statistical analysis of achievement patterns. Particular detail is sought on:

- basic parent characteristics
- child's past reading engagement
- parents' own reading engagement
- home reading resources and support
- parents' background
- parents perceptions of and involvement in child's school
- extent of school choice

Questionnaire on educational career (international option)

This brief questionnaire is comprised of only six student questions:

- extended absences
- frequency of changing schools
- expected educational attainment
- lessons or tutoring outside of school
- marks received in language

Questionnaire on student familiarity with ICT (international option)

This questionnaire is designed to ascertain a student's access to computer technologies as well as the extent of use and capabilities for different educational applications. Specific dimensions are:

- availability of ICT devices at home
- availability of ICT equipment at school
- use of computers for educational activities in school
- use of computers for educational activities outside of school
- student capability at computer tasks
- attitudes towards computer use

The first two questionnaires, *i.e.* the student and school questionnaires, are used to provide background information to interpret the achievement results in all participating countries and economies. The last three can only be used for countries and economies which incorporated them as international options. However, the overall collection of detailed information on background variables at all levels of education makes it possible to inquire into particular policy themes which may contribute to better educational achievement in reading and other subjects. PISA 2009 is dedicated to collecting empirical evidence and informing policy making in a variety of relevant areas. To illustrate the use of the questionnaire information for improving educational policy, the following section provides examples of the types of policy themes that might be chosen for in-depth investigation using PISA results.

INFORMATION FOR IN-DEPTH INVESTIGATIONS

Based upon what has been learned from the analysis of earlier PISA studies, the information collected to assist in the interpretation of student performance in PISA 2009 has been enhanced in two ways. First, the accumulated experience acquired from the earlier PISA studies and the more recent scientific progress (Bransford, 2000) on the knowledge base for learning has informed which variables and questions are most essential for further analysis. More specifically, the PISA 2009 questionnaires attempt to capture background dimensions affecting reading performance that are reflected in the increasingly sophisticated literature on reading development that has emerged since the first effort to address reading in PISA 2000. Second, the increased focus on using PISA results to improve educational policy has identified several specific policy themes for which it is hoped that PISA 2009 data might be informative.

PISA 2009 will provide a rich data base to seek information on a variety of topics that are of importance to individual countries or provide an overall assessment of educational performance patterns across countries. Among the many policy themes that could be addressed, five are outlined below. Although considerable information has been collected in previous PISA cycles that bear on these themes, a special effort has been made in PISA 2009 to gain more refined detail about:

- system level indicators
- effective learning environments in reading
- school effectiveness and school management
- educational equity
- cost effectiveness

For each of these themes an attempt has been made to identify specific policy concerns that might be the focus of subsequent inquiry and to provide additional information that might help reply to those questions.

System level indicators

Most analyses addressing patterns of educational performance have focused on differences in features among individual students, classrooms, and schools that contribute to educational achievement. This is understandable because a plethora of educational studies shows that differences in instruction, curriculum, and school and home resources account for important differences in educational experiences and achievement results. However, national, federal or regional governments have relatively limited influence on the finer details of what happens in homes and schools. Rather, they are able to establish the larger organisational and resource framework in which education takes place and that might ultimately influence school and family behaviour. In particular, there are three dimensions at the system level which are both an active topic of educational policy and which might affect the educational performance at the system level. These are the degree of centralisation or decentralisation of decision-making authority, evaluation and accountability, and the degree to which secondary education is comprehensive or specialised.

In recent years many countries have been addressing the issue of how their schools can be more responsive to the needs of specific students, groups of students, and communities. When decision-making is vested in a central authority such as the national government, it is argued that teacher hiring and training and curriculum are too rigid to accommodate the types of differences in student learning found in the schools, and especially in countries with different social conditions and ethnicities. For this reason, many nations have established a variety of reforms to decentralise their schools that place educational decisions closer to the students and communities being served with the hope that this will improve school performance (Hannaway & Carnoy, 1993). Questions on centralisation and decentralisation of school finances, curriculum, teacher staffing, and other areas of school operations have been included in previous PISA surveys, but for PISA 2009 more decision areas are addressed to enable analysis of the impacts of different types of decentralisation on student performance.

Different forms of educational evaluation and accountability have also become more prominent over time. Educational entities at all levels from students and their families to classrooms, schools, regions and nations wish to ascertain the degree to which they are experiencing educational success. At the same time the measurement of educational outcomes provides indicators of accountability of the different decision-making entities in education. That is, the placement of authority and responsibility for decision-making at any particular level implies responsibility for results at that level, and the concern for accountability.

Countries and their regions have established different approaches to evaluation and accountability. Some sponsor periodic systems of testing to gain standardised information on student and school performance at national, federal and highly decentralised levels. Others require such evaluations, but leave it to the regional and local authorities to carry out testing and assessment. Others however lack systematic evaluations. But, accountability also extends to the consequences carried by evaluation results (Koretz, 2008; Carnoy, Elmore & Siskin, 2003). Some countries simply use their surveys of educational performance to inform the general public and the various educational entities. Others use it to provide rewards to schools and teachers for good results and create incentives for better performance. Evaluations can also include school inspections and various forms of individual schools' evaluation activities. They can be used to fix educational performance objectives for students. For example, end-of-course or other external exams might be required for course credit or graduation. Other countries add resources and technical assistance to improve schools where performance is low. The information on evaluation and accountability collected in PISA 2009 has been refined to consider the types of approaches that have been adopted and their possible consequences.

A much bigger debate has taken place over the structure of secondary education. Traditionally countries divided secondary schools between those with an academic focus and those with a vocational, professional, or technical focus. Academic secondary schools were designed to accommodate students who were preparing for further study at university. The other types of schools focused on students who would be entering the labour force directly or undertaking work apprenticeships or short courses to prepare for life in the labour force. At the end of secondary school, students would be divided between the two types of schools according to both their academic performance and their preferences or orientations. Typically academic secondary schools would choose only the higher performing students.

A historic debate has taken place within and among countries on whether such educational separation at a relatively early age denies academic opportunities for those who develop intellectually at a later age, and whether opportunities are determined according to the socio-economic status of the student's family with those of lower status relegated to the vocational institutions (Levin, 1978). Accordingly, many countries have considered establishing and maintaining comprehensive high schools that offer both academic and vocational courses where all students are required to undertake at least a common core of academic work. Even within such schools there are debates about whether academic classes should be heterogeneous in enrolments or streamed by ability. Since students enter educational systems characterised by different structures regarding comprehensiveness of curriculum and student enrolments, it is useful to provide measures of these differences to ascertain both their patterns and potential impact on achievement. Information is gathered in PISA 2009 with the goal of relating it to both overall achievement levels as well as equity in the distribution of achievement.

An in-depth report on this subject would pose a range of research questions and statistical methods to evaluate the potential impacts of decentralisation, evaluation and accountability, and secondary school structure. They would be constructed to explore the impact of these types of arrangements on the achievement of educational systems, schools, classrooms, and individual students. Whether causal relations can be inferred may be problematic, but consistency of patterns should be identified for further investigation.

Effective learning environments in reading

A great deal of research on learning effectiveness in reading has been undertaken since the publication of the PISA 2000 results which focused on reading (Kamil, 2010). In part this research activity was induced by the PISA reading results and the data that were made available in that report on opportunities to learn and improve reading. There have also been more general attempts in recent years to both produce and summarise the results on how to create reading success. All of the previous PISA surveys have gathered considerable information on the instructional strategies, curriculum, teaching resources, and home opportunities for enhancing student achievement. While not all of these survey questions are pertinent strictly to reading, it should be noted that even mathematics and science build on capable reading skills.

A major shift has taken place in the last decade in the student populations that are of interest for studying reading achievement. Most research on reading in the past was focused on the elementary school on the assumption that reading is so fundamental to further learning that it is considered to be a basic skill that must be acquired in the early years of schooling. Thus adolescents were considered to have developed their reading skills in the elementary school, and reading was not a subject of high priority at the secondary level.

In this respect two OECD surveys have shifted much of the focus to the entire educational system. The OECD's International Assessment of Adult Literacy Survey (IALS) found that many adults lacked fundamental literacy skills in understanding reading and applied mathematics, even among those who had attended or completed secondary school. But more recently, and largely as a result of the findings of PISA 2000, it became recognised that a substantial number of 15-year-olds are not proficient readers for the knowledge society. It seems reasonable to assume that reading still is a basic skill which should be acquired in early years, but this skill needs to be further supported and developed throughout life. Students who for some reason do not acquire good reading skills early in elementary school are disadvantaged in many ways in comparison to those who obtained those skills early on. Thus, the challenges of reading performance at the secondary level have been widely confirmed and have become topics of educational concern. This concern has been exacerbated by the growth of immigrant populations whose mother tongue differs from the official language of their adopted society and schools. But, even among native students, PISA 2000 and individual country studies have raised concerns about the status of struggling adolescent readers, ones who can, perhaps, identify and pronounce most words and sentences, but who have difficulties fully understanding content and meaning of what they are able to decipher (Deshler *et al.*, 2007). Because reading is so fundamental to overall literacy and the learning of the other subjects, poor reading performance is an obstacle, in itself, to secondary school academic achievement and further education.

Accordingly, an in-depth investigation of effective learning environments in reading would collect information in PISA 2009 that would enable further research and study for improving the conditions to advance reading performance. That report would contain considerable insights into teaching and learning conditions and their possible relationships to achievement in reading and other subjects. It would enable a deeper range of research that would explore descriptive patterns as well as those that come closer to attempts to model the relationships in a causal manner and to test various hypotheses about the conditions that lead to greater achievement.

This report would address the influence of variables at the level of the system, the school, the classroom, and the individual student and family environment by drawing on the considerable information collected at each level. What is particularly unique about the approach in PISA 2009 is that it advances the types of background and explanatory information collected in the earlier survey on reading for PISA 2000 by building on subsequent research. Thus, it adds more information on teachers that has been identified as potentially pertinent to learning. It places greater emphasis on students' higher order skills, self-regulated learning, and constructivist approaches to learning, all which have been investigated and found to show great promise in raising student understanding and knowledge. It also places more stress on learning facilitation and the student role in learning, including levels of student interest, motivation, and engagement. And in considering the opportunity to learn, it explores more fully the content of reading activities at home and at school.

To address policy relevant concerns, an in-depth report on effective learning environments in reading could incorporate questionnaire items on teacher characteristics such as professional knowledge, teaching motivation, and instructional methods; on classroom characteristics such as class size, student composition, and classroom climate; and the teaching processes that are incorporated into the learning environment. In addition, it could take account of background variables on students such as socio-economic, immigrant status, gender, and their learning approaches and attitudes towards learning. An attempt could be made to uncover both salient patterns of relations between these variables, many of which can be altered or partially changed, and the apparent achievement results.

School effectiveness and school management

A considerable amount of research has been carried out in an attempt to differentiate the characteristics of effective schools from those of ineffective schools. The purpose is to identify the characteristics of schools that are effective in raising student achievement and to apply this knowledge to improve schools. Certainly, this is a potentially important application of information collected by PISA 2009 for guiding school improvement in the participating countries and economies. However, it is important to note that PISA data only captures the situation of students at one point in time in a year.

In general, research on effective schools develops statistical contrasts among successful schools enrolling students of lower socio-economic status in the same geographical area with schools that are not successful academically. Schools with considerably higher academic achievement for the same types of students are considered to be effective schools , and those with poor results are considered to be ineffective schools . The two groups of schools are then compared for their operational features and resources to ascertain how they seem to differ in such areas as goals, leadership, teachers, curriculum, organisational climate, instruction, and evaluation. Substantial differences along these dimensions are noted between effective and ineffective schools serving the same types of students, and these effective school dimensions become the focus of policy attempts to improve schools (Scheerens, 2000; Teddlie & Reynolds, 2000).

Research on effective schools using PISA 2009 data can help to identify potential features of schools that have shown previous connections to student achievement. An in-depth report on school effectiveness and school management could attempt to include information on all of these effectiveness dimensions in studies of the determinants of educational achievement for PISA 2009. That is, using the effective school correlates as a guide, it could construct variables and potential relationships to attempt to explain statistically the differences in student achievement among and within countries. Since many of these variables will be ones amenable to policy manipulation, it should be possible to suggest generally among countries and for individual countries the most promising policy levers for raising achievement.

A particularly important feature of effective schools is that of the school leadership. Virtually all studies of effective schools find that school leadership is central to school effectiveness and identify specific features of such leadership that appear to be particularly important. Effective school leaders put particular effort into establishing and maintaining academic goals among students and school staff as well as maintaining a safe and orderly environment and providing the teaching support and instructional policies that create academic growth among students. They are also attentive to evaluating results and using evaluations to improve the school operations.

The PISA 2009 questionnaires contain considerable data that would be useful for assessing both school effectiveness and school management and leadership. For example, they reflect questions on the specific leadership activities undertaken by the principals of participating schools, activities that have been linked to student achievement

(Hallinger & Heck, 1998). Thus, in addition to the overall attempt to discern policy influences of schools on achievement, a special effort could be devoted to that of school management and leadership.

Since school effectiveness research attempts to either uncover or infer causal relations between school characteristics and student achievement, there are a number of challenges that must be undertaken in PISA 2009 in order to be able to provide meaningful outcomes. One challenge is that significant numbers of 15-year-olds among countries have just begun to attend secondary schools or have attended them for only one or two years. Thus, their present achievement as measured in PISA 2009 is likely to be more closely connected to their previous years of schooling than to the characteristics of their present schools. However, this can be partially addressed by choosing countries for the analysis where the students have attended their present schools for many years. In addition to the findings that are developed from PISA 2009 on effective schooling and school management directly, it is likely that this report could develop a future design for value-added measures where prior achievement is accounted for in exploring how much achievement takes place in the present school.

Educational equity

A central pre-occupation of PISA is that of fairness or justice in access to education and the opportunity to learn. Virtually all countries participating in PISA 2009 recognise that the fullest development of all of their human resources possible is crucial to a just and prosperous society. An in-depth investigation of educational equity and equality requires delineation of two criteria (Coleman, 1993). The first criterion is the identification of population subunits that are to be scrutinised for equity. Although different societies may identify different groups for comparative study, the common population categories that are often used to study equity in education are: gender, socio-economic status, race, religion, ethnicity, degree and type of disability, immigrant status, language, geography (*e.g.* regions or urban/rural distinctions), and public/private school enrolment.

The second concern is that of how to measure equity. Equity can be assessed in terms of the distribution of access to schooling, learning resources and opportunities, and educational outcomes. The richness of PISA 2009 is that most of the population comparison categories are available in the data, and versions of each equity criterion can be used for investigations on educational equity. Other than religion, ethnicity, and detailed data on disabilities, the background questionnaires collect information on the other sub-population groups as well as abundant measures of schooling characteristics and achievement outcomes in all three subjects.

Analyses could be done on linking school effectiveness variables to their distribution. For example, home opportunities, school organisation, instructional strategies, curriculum, class size, and other opportunity-to-learn variables, leadership, and teacher characteristics that have been linked to student achievement could be evaluated for their distribution across different sub-populations of students. Thus, these variables could be examined not only for their apparent influence on the overall level of achievement, but also on equity in their own distribution and the implications for equity in achievement. Specific resources that are used for compensatory education, that is to compensate for educational disadvantage, could be assessed for their distribution across needy populations (Field, Kuczera & Pont, 2007). Analyses could also be undertaken to ascertain if there is a loss of effectiveness when equity policies are implemented, that is, if overall school effectiveness suffers when inequities are addressed. Of particular policy importance, public interventions for reducing inequities such as adding resources to classrooms and schools and providing other compensatory policies could be evaluated for their efficacy at improving equity. And, a specific attempt could be made to ascertain the impact of student composition or segregation of student subgroups on educational performance, a topic of great currency for addressing equity in education.

Finally, an in-depth investigation on this issue would represent a unique opportunity to explore how educational equity has changed since 2000. The previous PISA reports contain many of the same background questions found in PISA 2009. This means that trends in educational resources, opportunities, and outcomes could be assessed for countries as a whole as well as for their subpopulations. In particular, socio-economic and gender differences in achievement results could be compared with changes in educational policy as evidenced by the responses to similar questions that have been used in the four administrations of the PISA studies from 2000 to 2009. This type of longitudinal analysis could also be carried out for other subgroups of students. Thus, such an in-depth investigation would be able to provide concrete information on how equity has changed both among and within countries over almost a decade.

Cost-effectiveness

All educational systems are constrained by available resources. In the quest for improving both levels of academic performance and educational equity, choices must be made among different educational policies in terms of their contributions to effectiveness. But, such choices also have important consequences for costs. That is, there may be considerable differences in costs of educational strategies with similar effectiveness requiring larger budgets and greater resources for some strategies of equal effectiveness than others. Cost-effectiveness analysis takes into account not only the educational impact of any particular approach, but also its costs (Levin & McEwan, 2001). Its application enables the adoption of educational practices that provide the greatest improvement relative to their cost by accounting for both the effectiveness of different alternatives and the resources that they require. In so doing, all resources can be used most efficiently and a given budget and other resources not reflected in the budget can produce the largest possible gain in student achievement and equity consistent with resource constraints.

The effectiveness component of the cost-effectiveness method could be derived from the previous analyses of school effectiveness and effective learning environments, as outlined above. Equity results could be summarised as outlined above. Cost-effectiveness analysis combines this information on effectiveness of alternatives with costs to compare the productivity of alternatives relative to their resource requirements. Resource measures include the value of both public and private costs, measures which are not normally summarised in government expenditures. Public budgets use their own accounting practices which often distort costs of government outlays and ignore costs paid by families, other government agencies, and non-governmental organisations. Accordingly, the most appropriate method for estimating costs according to economists is to set out the specific personnel, facilities, and other resources that are required for each alternative and to estimate their costs directly, a full cost accounting process known as the ingredients or resource method.

An in-depth investigation of cost-effectiveness could then begin with a summary of the achievement and equity consequences of different policy alternatives and a description of the resources required for each one. Data on costs of programmes is not collected in PISA 2009, so the data would have to be collected independently for each country included in the analysis. The total costs of each alternative that has shown educational advantages in raising achievement or improving equity would then be estimated and compared with the magnitude of expected educational results. These comparisons would allow a ranking of alternatives for raising achievement or providing greater equity by their efficiency in the use of resources.

It must be noted that although such an analysis can be done among countries, the averages in terms of both effectiveness and costs tend to hide important differences in both costs and effectiveness that are unique to individual countries. Further, educational policy is set on a country-by-country basis, so that it makes sense to carry out the cost-effectiveness analysis for each country to guide its policy decisions.

Cost-effectiveness analysis can be applied to any policy which yields effectiveness results. For example, to the degree that decentralisation, accountability, school structure, school choice, teacher selection, class size, curriculum, instructional strategies, desegregation, and other educational policies are associated with improved school and student performance, it is possible to match the results for such improvement with the costs of obtaining the gains. Then the educational outcomes relative to their costs could be compared for each of the feasible policy alternatives. The goals of an in-depth investigation on cost-effectiveness would be to elaborate on the method and apply it to the analytic results on effectiveness, relying primarily on information collected for PISA 2009 in the questionnaires.

The systematic attempt to use the research findings on learning and conceptual linkages in interpreting PISA 2009 achievement results requires considerable background information on educational systems, schools, classrooms, and students and their families. Obtaining this information is made possible through the survey questionnaires which have been carefully designed to collect the pertinent interpretive information. Through this most comprehensive approach to pertinent data collection, PISA 2009 will make its most extensive effort to address the policy inferences and consequences of its findings.

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ANNEX A1

Print reading sample tasks

The print reading sample tasks are examples of questions students answered in the PISA 2009 survey to assess their competencies in reading printed text.

Note that the numbering of the questions is identical to the numbering used in the test booklets given to students.

PRINT READING UNIT 1

Macondo

Dazzled by so many and such marvellous inventions, the people of Macondo did not know where their amazement began. They stayed up all night looking at the pale electric bulbs fed by the plant that Aureliano Triste had brought back when the train made its second trip, and it took time and effort for them to grow accustomed to its obsessive toom-toom. They became indignant over the living images that the prosperous merchant Don Bruno Crespi projected in the theatre with the lion-head ticket windows, for a character who had died and was buried in one film, and for whose misfortune tears of affliction had been shed, would reappear alive and transformed into an Arab in the next one. The audience, who paid two centavos apiece to share the difficulties of the actors, would not tolerate that outlandish fraud and they broke up the seats. The mayor, at the urging of Don Bruno Crespi, explained by means of a proclamation that the cinema was a machine of illusions that did not merit the emotional outburst of the audience. With that discouraging explanation many felt that they had been the victims of some new and showy gypsy business and they decided not to return to the movies, considering that they already had too many troubles of their own to weep over the acted-out misfortunes of imaginary beings.

Macondo is a piece of prose from the novel One Hundred Years of Solitude by the Colombian author Gabriel Garcia Márquez. It is classified as belonging to the personal situation because it was written for readers' interest and pleasure. The Macondo unit in PISA is introduced with a brief paragraph to orientate the reader: "The passage on the opposite page is from a novel. In this part of the story, the railway and electricity have just been introduced to the fictional town of Macondo, and the first cinema has opened." The people's reaction to the cinema is the focus of the passage. While the historical and geographical setting of the extract is exotic for most readers, going to the movies is within the experience of 15-year-olds, and the characters' responses are at the same time intriguing and humanly familiar. Within the continuous text format category, Macondo is an example of narrative writing in that it shows, in a manner typical of this text type, why characters in stories behave as they do. It records actions and events from the point of view of subjective impressions.

Question 1: MACONDO

What feature of the movies caused the people of Macondo to become angry?

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Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Integrate and interpret: Develop an interpretation
Question intent	Infer a reason for characters' behaviour
Item format	Open constructed response

CODING GUIDE

Code 2: Refers to the fictional nature of movies or more specifically to actors reappearing after they have "died". May quote directly from the third sentence ("...a character who had died and was buried in one film, and for whose misfortune tears of affliction had been shed, would reappear alive and transformed into an Arab in the next one …") or the last phrase ("the acted-out misfortunes of imaginary beings.").

- People who they think have died came back to life.
- They expected the films to be true and they aren't.
- They think that the man in the film has pretended to die, and that they are being taken for fools.
- A character who had died and was buried in one film would reappear alive in the next one.
- They don't understand that the films are fiction.
- Because actors whose characters had died in the previous film returned as new characters in the next film. The audience felt they were being robbed of their emotions. [Elements of both 2 and 1.]
- They thought they had enough problems of their own without watching pretend people act out problems. [Clear understanding of the part "fiction" plays in the people's anger, though has taken it a stage further.]
- Because one of the actors was buried in the film and he came back as an Arab. [Marginal: very specific.]

Partial credit

Code 1: Refers to fraud or trickery, or to the audience's thwarted expectations. May quote directly "that outlandish fraud" or "the victims of some new and showy gypsy business".

- They think they are being defrauded.
- Because they feel they have wasted their emotions for nothing.
- They felt they had been the victims of some new and showy gypsy business.
- They would not tolerate that outlandish fraud.
- Because they paid 2 centavos apiece for that outlandish fraud they could not tolerate. [Partly direct quotation from lines 9-10; not specific reference to the nature of the fraud.]
- Because they were unaware of the workings of it. [Take as a way of saying "fraud" (general).]

No credit

Code 0: Gives insufficient or vague answer.

- They were angry with Bruno Crespi.
- They didn't like the films.
- They want to get their money back.

- They thought they had been victims.
- They were violent.
- They were stupid.
- They are expressing their feelings.
- They paid 2 centavos and didn't get what they wanted. *["What they wanted" is too vague.]*

OR: Shows inaccurate comprehension of the material or gives an implausible or irrelevant answer.

- They felt they shouldn't be bothered with other people's problems. *[Wrong: the people DID want to be bothered with REAL people's problems.]*
- It's the only way they have of protesting at wasting their money.
- They were angry because they had to see a person that was dead and buried. *[The quoted section gives the sense of "they did not like seeing dead people in films" – incorrect interpretation.]*

Code 9: Missing.

The text positions the reader at a distance – albeit a sympathetic distance – from the people of Macondo. To gain full credit for this item, it is necessary to stand outside the text and recognise the difficulty these unsophisticated villagers have in coming to grips with the difference between fiction and real life. For most modern readers, this difficulty would seem unusual, and contrary to expectations. Just over half of the students in the field trial were able to demonstrate that they could develop this interpretation. The partial credit response requires a less challenging imaginative act on the reader's part: understanding that people get angry if they feel that they are being tricked is, for most people, quite easy to imagine. This kind of answer gains partial credit because it is not wrong – but it only tells part of the story. Although a relatively small percentage of students in the field trial gave this kind of response, their overall reading ability was substantially lower than that of those who gained full credit.

Question 3: MACONDO

At the end of the passage, why did the people of Macondo decide not to return to the movies?

A. They wanted amusement and distraction, but found that the movies were realistic and depressing.

B. They could not afford the ticket prices.

C. They wanted to save their emotions for real-life occasions.

D. They were seeking emotional involvement, but found the movies boring, unconvincing and of poor quality.

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Integrate and interpret: Form a broad understanding
Question intent	Infer motives for characters' actions
Item format	Multiple choice

CODING GUIDE

Full credit

Code 1: C. They wanted to save their emotions for real-life occasions.

No credit

Code 0: Other.

Code 9: Missing.

This task requires integrating and interpreting to form a broad understanding. In order to gain credit, students need to synthesise elements across the text to identify the reason that the characters in the story behaved as they did at the end. In selecting alternative C, they must reject some reasons that could plausibly explain why people might decide not to go the movies, represented by distractors that are based on preconceptions rather than on the text.

Question 4: MACONDO

Who are the "imaginary beings" referred to in the last line of the passage?

A. Ghosts.

B. Fairground inventions.

C. Characters in the movies.

D. Actors.

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Integrate and interpret: Develop an interpretation
Question intent	Interpret a referent when the antecedent is implied rather than stated
Item format	Multiple choice

CODING GUIDE

Full credit

Code 1: C. Characters in the movies.

No credit

Code 0: Other.

Code 9: Missing.

To gain credit for this item, students need to follow a chain of references that begins about one-third of the way into the passage. Almost three quarters of the students who took part in the field trial were able to identify the "imaginary beings" with the characters who are first referred to as "living images". The need to make connections across the text explains the item's classification in the integrate and interpret aspect category. Most of those who did not select the correct alternative chose option D, apparently confusing the fictional with the real.

Question 5: MACONDO

Do you agree with the final judgement of the people of Macondo about the value of the movies? Explain your answer by comparing your attitude to the movies with theirs.

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Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Reflect and evaluate: Reflect on and evaluate the content of a text
Question intent	Compare characters' attitudes with personal knowledge and experience
Item format	Multiple choice

CODING GUIDE

Full credit

Code 1: Refers to attitudes to "realism" and/or emotional involvement in the movies. Answer must be consistent with the idea that the people of Macondo are looking for realism in the movies. Comparison between Macondo and personal experience/attitude may be implied or stated.

- *Once you realise it's not real you can just use the cinema for escapism. There's no need to get so involved in the lives of the characters.*
- *Yes, I agree, there's enough suffering in the world without making it up.*
- *No, people understand that when you go to the movies what happens on the screen isn't real.*
- *Unlike the Macondo people, I can cry my eyes out during the film, but I forget about it when I leave the cinema.*
- *I agree with them. Why do people want to upset themselves about movies? That's why I'm doing science, because it's about fact not fantasy.*
- *I enjoy the movies because it makes me focus on other people's problems and not mine.*
- *It depends. If the film is rubbish I feel like walking out, but if it's good you are caught up in it and don't mind that it's not true.*
- *No, I enjoy movies for entertainment.*
- *Yes the movies are just made up. It's way better when you see people acting things out live.*
- *No, in movies events are usually exaggerated.*
- *I do not agree with their reactions because movies are a form of entertainment and are not to be taken too seriously. However the people of Macondo do not know any better and so I understand how they would feel.*

OR: Refers to social, historical or cultural context, for example in terms of comparative familiarity with technology, changes in social experience. Answer must be consistent with the idea that the people of Macondo are looking for realism in the movies. Comparison between Macondo and personal experience/attitude may be implied or stated.

- *The people of Macondo were primitive and reacted emotionally. I and most other people nowadays are more sophisticated.*
- *They started to watch the films from a wrong position. They didn't understand that this was not the news, but entertainment. From that point of view their reaction is understandable. Films are of course to be seen as entertainment. That is the point with them.*
- *People these days don't get upset by films.*
- *Yes, I would agree if I were one of them because they had never seen it before.*

No credit

Code 0: Gives insufficient or vague answer.

- I'm like the people of Macondo because I often think that the movies are a waste of time.
- I love the movies. I can't understand their reaction.

OR: Shows inaccurate comprehension of the material or gives an implausible or irrelevant answer

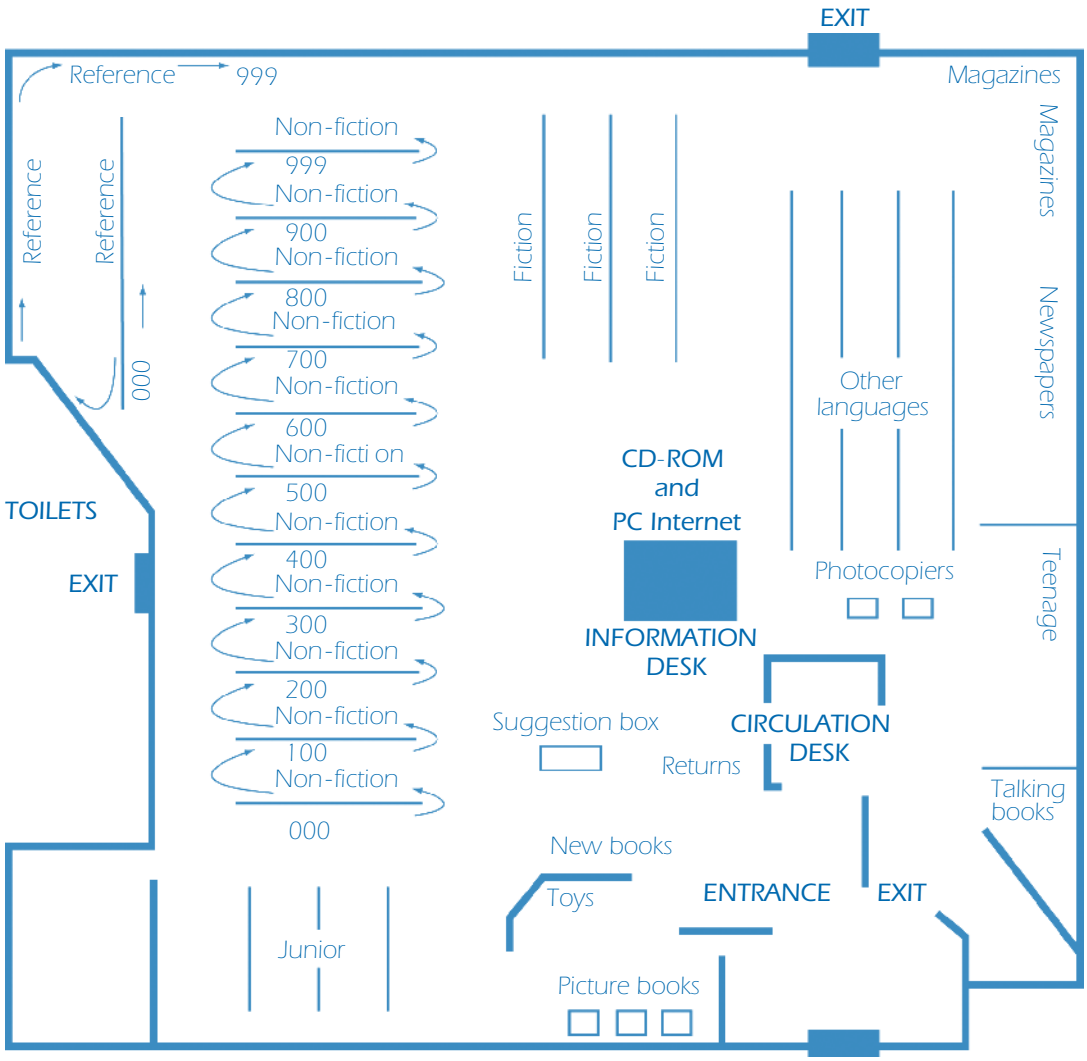
- Yes, it seems the movies, rather than being relaxing and easy to watch, were realistic and emotional. Movies are a form of entertainment, a scape-goat and a way of forgetting the troubles of real-life for a laugh. The people of Macondo were disappointed because the movies they saw were not relaxing but rather quite full-on and they wanted something that would entertain them. *[First two sentences by themselves are not relevant to the question. Last sentence indicates a misunderstanding of the text.]*
- No, they should be more expensive and have cup holders, popcorn, frozen coke and lollies. The arm rests should lift up, footrests, surround sound. *[Maybe a joke, but if not – a misreading of the text.]*
- These days there are laws against damaging property in cinemas. *[Answer focuses on behaviour rather than attitude.]*
- We have better cinemas now. *[Irrelevant]*
- Yes because the movie wasn't very good and would have made them nervous. *[Misunderstood the question.]*

Code 9: Missing.

This is a good example of a reflect and evaluate item that asks readers to draw on their own experience and ideas and compare them with those provided in the text. To gain credit for this item students must assess the views attributed to the people of Macondo against their own knowledge of the world, providing some evidence that they have an understanding of what is said and intended in the text. While this kind of item does not demand critical evaluation in the sense of applying any kind of formal analysis or reasoning, it does require that readers engage with the narrative to the extent that they compare or contrast its content with personal beliefs. The coding guide indicates that contradictory responses can gain full credit as long as there is evidence of understanding of the issue in focus, and of their own reflection (for example, compare "Yes, I agree, there's enough suffering in the world without making it up" and "No, people understand that when you go to the movies what happens on the screen isn't real"). About half of the students in the field trial sample gained credit for this item.

PRINT READING UNIT 2

Library Map



The library map that forms the basis of this unit is an example of a kind of everyday non-continuous text that is often encountered in work, personal, public and educational settings. The context of this example is defined as public because the map relates to the activities of a community (a public library) and assumes anonymous contact with the reader. In terms of text type, the map is classified as description, since the information it contains refers to properties of objects in space and their relationship to one another.

Question 5: LIBRARY

For school you need to read a novel in French. On the map draw a circle around the section where you would be most likely to find a suitable book to borrow.

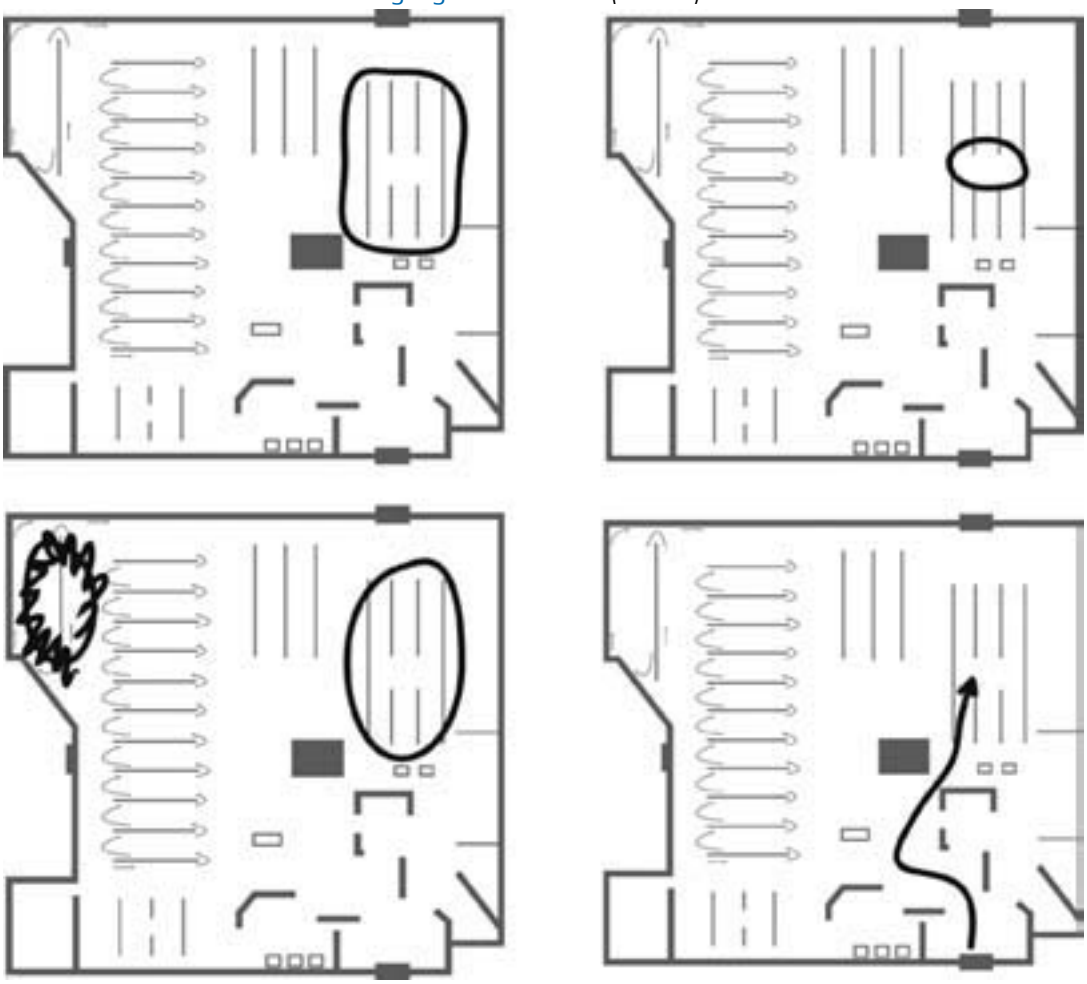
Framework Characteristics

Situation	Public
Medium	Print
Text format	Non-continuous
Text type	Description
Aspect	Access and retrieve: Retrieve information
Question intent	Locate information that matches on one factor using low-level inference
Item format	Short response

CODING GUIDE

Full credit

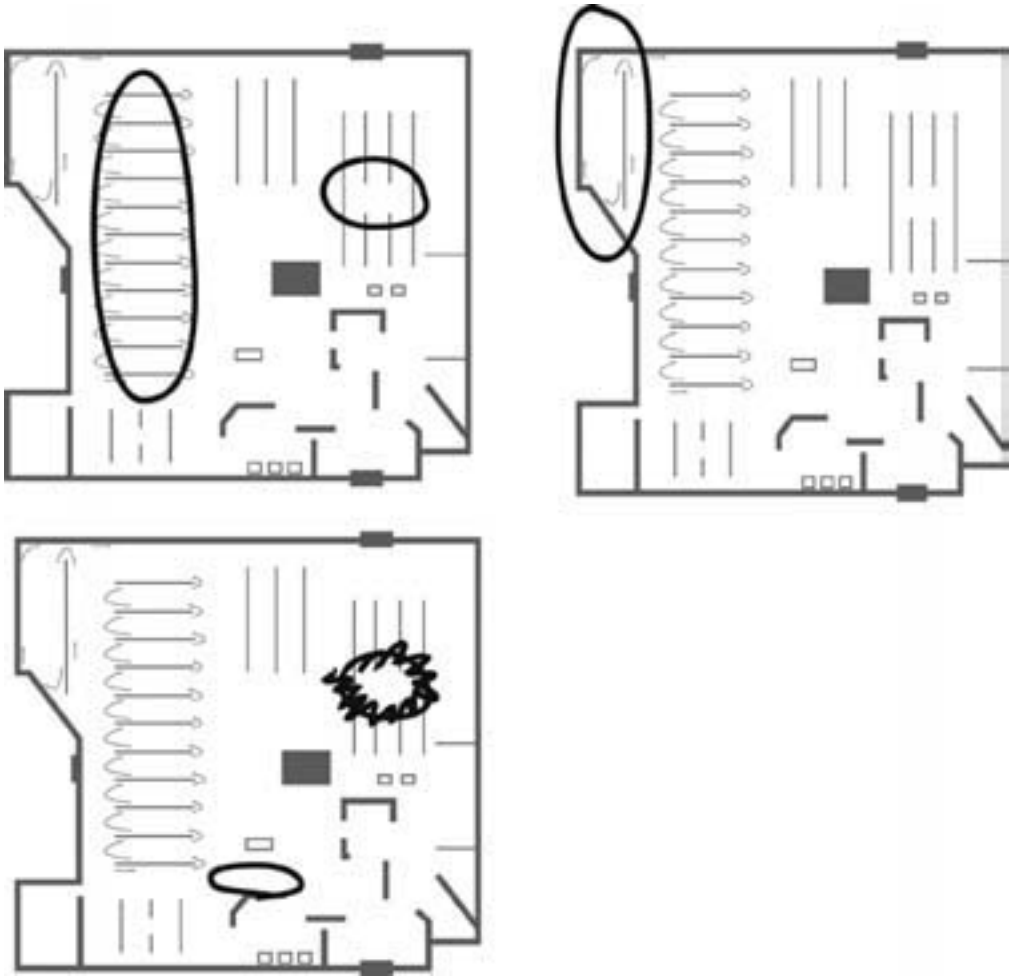
Code 1: Circles the words "other languages" or the lines (shelves) near the words.



[Ignore crossed-out answer.]

No credit

Code 0: Other, including circling which includes any other feature of the map completely.



Code 9: Missing.

This short response item requires that the reader search for, locate and select relevant information from the information space: in this case, a map. The required information is found in a single location rather than multiple locations, a factor that is likely to reduce difficulty. On the other hand, the match between the words in the task and the caption on the map is not literal: the reader must make an inference to categorise "French" as "Other languages". (A translation and adaptation note instructed that in national versions of the item the language referred to in the item should be a foreign language commonly taught in schools.) Nevertheless, this is a rather easy item, with more than four fifths of the students in the field trial able to identify the right section of the library. As indicated in the full credit examples provided with the coding guide, students could mark the text in a number of different ways to show their answer. Although the question specifies that a circle should be drawn to show the answer, the format of the response is not the critical criterion for awarding credit: what is critical is whether or not the response clearly meets the intent of the question – "locating information that matches on one factor using low-level inference".

Question 7A: LIBRARY

Where are *New books* located?

A. In the fiction section.

B. In the non-fiction section.

C. Near the entrance.

D. Near the information desk.

Library scoring 7a

Note: The correct answer is C: "Near the entrance". This question is for information only and will not independently contribute to the student's score. The answer is taken into account in assessing the response to Question 7B.

Question 7B: LIBRARY

Explain why this location might have been chosen for *New books*.

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Framework Characteristics

Situation	Public
Medium	Print
Text format	Non-continuous
Text type	Description
Aspect	Reflect and evaluate: Reflect on and evaluate the content of a text
Question intent	Hypothesise about the location of a feature of a map drawing on personal knowledge and experience
Item format	Open constructed response

CODING GUIDE

Full credit

Code 2: Answer to Part A correct. Gives an explanation which is consistent with the answer "near the entrance".

- People will see them as soon as they walk in.
- They are away from the other books, and people will find them easily.
- So people can look at them first. [Implies recognition that the new books are near the entrance.]
- So they are very visible.
- They are clearly visible and not hidden away among the bookshelves so that you have to search for them.
- You pass it on your way to fiction.

OR: Answer to previous question Part A correct. Gives an explanation which shows understanding of the location of the new books in relation to a part of the library other than the entrance.

- It gives children a chance to play while adults look around. [Recognises that the new books are near the Toys section.]
- When people are returning books they will see the new ones.

Partial credit

Code 1: Answer to Part A incorrect. Gives an explanation which is consistent with the answer given for previous question.

- [Answer to Part A: In the fiction section.] Because this is the part of the library that most people would be using, so they would notice the new books.
- [Answer to Part A: Near the information desk.] Because they are next to the Information Desk, the librarian can answer questions about them.

No credit

Code 0: Gives insufficient or vague explanation regardless of whether answer to Part A is correct or incorrect.

- Because it's the best place.
- They are near the entrance too. [States where the new books are, without offering explanation.]
- The New books are near the suggestion box. [States where the new books are, without offering explanation.]

OR: Shows inaccurate comprehension of the material or gives an implausible or irrelevant explanation, regardless of whether answer to Part A is correct or incorrect.

- So people would notice them when they were looking at the newspapers. [Inaccurate–implies that new books are near the newspapers.]
- Because there is nowhere else to put them. [implausible]
- Some people like to read new books. [Answer is irrelevant to question.]
- [Answer to Part A: In the fiction section.] So that they are easy to find. [answer irrelevant to answer given for Part A]

Code 9: Missing.

The coding rules for this task are somewhat complicated. Students are asked two questions – one multiple-choice and one constructed response – but only the second of these is coded directly. As this task contributes to the Reflect and evaluate scale, the multiple-choice component, which predominantly requires retrieval of information, does not earn any credit on its own. However, the multiple-choice question is taken into account in the coding of the second, constructed response question.

To gain full credit, the response must include both accurate reading of the map (locating the New books near to the entrance) and a hypothesis about the reason for locating the New books in that position. To make such an hypothesis, readers need to consult their own experience or knowledge – in this case about the way libraries work and the way they are used by the public. In the PISA context, the outside knowledge required is intended to be within the expected range of 15-year-olds' experiences.

Students receive only partial credit if they have failed to correctly locate the New books on the map, but have given a plausible hypothesis about the reason for locating New books in a particular position. Like the full credit responses, this kind of response fulfils the intent of reflecting on content that is the main thrust of this task.

This was an easy item, with over four fifths of the students in the field trial gaining full credit.

PRINT READING UNIT 3

Student Opinions

There are so many people out there dying from hunger and disease, yet we are more concerned about future advancements. We are leaving these people behind as we attempt to forget and move on. Billions of dollars are poured into space research by large companies each year. If the money spent on space exploration was used to benefit the needy and not the greedy, the suffering of millions of people could be alleviated.

Ana

The challenge of exploring space is a source of inspiration for many people. For thousands of years we have been dreaming of the heavens, longing to reach out and touch the stars, longing to communicate with something we only imagine could exist, longing to know... Are we alone?

Space exploration is a metaphor for learning, and learning is what drives our world. While realists continue to remind us of our current problems, dreamers stretch our minds. It is the dreamers' visions, hopes and desires that will lead us into the future.

Beatrice

We ruin rain forests because there is oil under them, put mines in sacred ground for the sake of uranium. Would we also ruin another planet for the sake of an answer to problems of our own making? Of course!

Space exploration strengthens the dangerous belief that human problems can be solved by our ever-increasing domination of the environment. Human beings will continue to feel at liberty to abuse natural resources like rivers and rain forests if we know there is always another planet around the corner waiting to be exploited.

We have done enough damage on Earth. We should leave outer space alone.

Dieter

The earth's resources are quickly dying out. The earth's population is increasing at a dramatic rate. Life cannot be sustained if we continue to live in such a way. Pollution has caused a hole in the ozone layer. Fertile lands are running out and soon our food resources will diminish. Already there are cases of famine and disease caused by over-population.

Space is a vast empty region which we can use to our benefit. By supporting exploration into space, one day we may find a planet that we can live on. At the moment this seems unimaginable, but the notion of space travel was once thought of as impossible. Discontinuing space exploration in favour of solving immediate problems is a very narrow-minded and short-term view. We must learn to think not only for this generation but for the generations to come.

Felix

To ignore what the exploration of space has to offer would be a great loss to all mankind. The possibilities of gaining a greater understanding of the universe and its beginnings are too valuable to waste. The study of other celestial bodies has already increased our understanding of our environmental problems and the possible direction Earth could be heading in if we don't learn to manage our activities.

There are also indirect benefits of research into space travel. The creation of laser technology and other medical treatments can be attributed to space research. Substances such as teflon have come out of mankind's quest to travel into space. Thus new technologies created for space research can have immediate benefits for everyone.

Kate

The stimulus for the unit Student Opinions consists of five short argumentative texts that offer opinions about space research. Because it is based on writing by students in their final year of school, the text is classified as educational in terms of situation. All of the short pieces that make up the stimulus for this unit are continuous, but as they were generated independently, and are juxtaposed for the purposes of the assessment, the format category is multiple texts. The stimulus is classified as argumentation, as the texts set forth propositions and attempt to persuade the reader to a point of view.

Question 1: STUDENT OPINIONS

Which of the following questions do the students seem to be responding to?

A. What is the major problem facing the world today?

B. Are you in favour of space exploration?

C. Do you believe in life beyond our planet?

D. What recent advances have there been in space research?

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Multiple
Text type	Argumentation
Aspect	Integrate and interpret: Form a broad understanding
Question intent	Identify a common theme across several short texts
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: B. Are you in favour of space exploration?

No Credit

Code 0: Other responses.

Code 9: Missing.

Like many Forming a broad understanding items, this item requires the student to focus on more than one part of the text – deducing the theme by recognising a particular category of information implied in each of the five short texts. Students need to select a question from the four alternatives offered that applies to all five texts. Such a task indicates whether the student can distinguish key ideas and generalise. Less than two-thirds of the students gained credit for this item. Many of those who did not select the correct alternative opted for the first distractor, "What is the major problem facing the world today?" One reason for this may be that it plausibly applies to the first of the texts; and perhaps also it represents a kind of "stock issue" that students might expect to see, rather than the issue that all the texts are actually responding to.

Question 3: STUDENT OPINIONS

Which one of the writers **most directly** contradicts Felix's argument?

A. Dieter.

B. Ana.

C. Kate.

D. Beatrice.

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Multiple
Text type	Argumentation
Aspect	Integrate and interpret: Develop an interpretation
Question intent	Recognising a counter-argument
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: A. Dieter

No Credit

Code 0: Other responses.

Code 9: Missing.

The difficulty of this item – with less than one-third of the students in the field trial selecting the correct alternative – can be attributed to several factors. Firstly, it requires identifying a contrast, a skill that has been established empirically as intrinsically more difficult than finding a point of similarity. Secondly, there are no explicit markers (such as "for" and "against") showing that contrary views are being expressed; the reader must infer the relationships. An added difficulty is that the comparisons and contrasts with Felix's opinion must be made several times, with each of the other four student opinions. Further, the basis of the contradiction is un-stated. Students need to generate their own categories for comparison, which in this case are not just opposing views about the merits of space research but also the grounds for the opinions: while both Ana and Dieter argue, in contrast to Felix, that space research is a bad idea, only Dieter directly contradicts Felix's view that the reason to pursue space research is to deal with the problem of diminishing resources on earth.

Question 6: STUDENT OPINIONS

Thinking about the main ideas presented by the five students, which student do you agree with most strongly?

Student's name: .....

Using your own words, explain your choice by referring to your own opinion **and** the main ideas presented by the student.

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Framework Characteristics

Situation	Educational
Medium	Print
Text format	Multiple
Text type	Argumentation
Aspect	Reflect and evaluate: Reflect on and evaluate the content of a text
Question intent	Assess claims made in a text against personal knowledge and values
Item format	Open constructed response

CODING GUIDE

Full Credit

Code 1: Shows accurate comprehension of the chosen student's position regarding space exploration AND explains reason for agreeing with it. Must identify an argument or set of arguments which is unique to the chosen student (*e.g.* needs to do more than say whether the student is for or against space research). Must explicitly or implicitly refer to one of the main arguments of the chosen student, by:

(1) introducing own supporting argument (in this case the answer may also quote or closely paraphrase the text); AND/OR

(2) using own words to interpret or summarise the chosen student's argument.

Summaries of each student's main argument(s) follow:

Ana: Must state or imply that Ana is against space exploration and refer explicitly or implicitly to her argument that we should use resources to help humans (in need) rather than for space research.

- It is more important to help people on earth than to waste money on space technology. [Uses own words to rephrase Ana's argument.]
- Ana – I feel that we should take care of what is going on in our own world before we blow all our money on space exploration. I understand the importance of some exploration but I think disease and famine need to be helped out of this world first. [Summarises Ana's argument in own words and adds own comment.]

Beatrice: Must state or imply that Beatrice is in favour of space exploration and refer explicitly or implicitly to her argument that space research is a positive expression of human endeavour. May refer to Beatrice's concern for taking a long-term view but must explicitly or implicitly distinguish her position from Felix's.

- Beatrice – "Space exploration is a metaphor for learning". I think it does not harm to widen our horizon. *[Quotes from passage and adds own supporting argument in the second sentence.]*

Dieter: Must state or imply that Dieter is against space exploration and refer explicitly or implicitly to his argument that space exploration is connected with environmental damage OR that humans will damage space if they have a chance OR that exploring space encourages us to do more damage to Earth. Accept answers which suggest that Dieter's priority is to improve Earth's environment OR that we need to change ourselves or our attitudes.

- Dieter – I agree with him because he is concerned with the environment and he thinks that we should leave outer space alone. *[Uses own words to summarise a main part of Dieter's argument.]*
- Dieter: Dieter says that we should stop wrecking the environment. I think this is the most important question facing our planet. *[Summarises one of Dieter's main points and adds supporting comment. Shows implicit understanding of Dieter's position on space research.]*

Felix: Must state or imply that Felix is in favour of space exploration and refer explicitly or implicitly to his argument that humans need to find another planet to live on AND/OR that life on earth cannot be sustained. May refer to Felix's concern about the environment but must explicitly or implicitly distinguish his position from Dieter's. May refer to his concern that we take a long-term view but must explicitly or implicitly distinguish his position from Beatrice's.

- Felix: I agree with Felix because unless we are willing to face extinction, there is no other place to go after we have wrecked the earth. *[Rephrases one of Felix's main arguments.]*

Kate: Must state or imply that Kate is in favour of space exploration and refer explicitly or implicitly to her argument that space exploration leads to an increase in knowledge AND/OR we can apply what we learn from space exploration to other things.

- Kate: We are expanding our knowledge all the time in different ways because of space research. *[Summarises Kate's main argument.]*

No Credit

Code 0: Gives insufficient or vague answer or focuses on a (trivial) detail of the argument.

- Ana: We should not leave people behind as we attempt to forget and move on. *[Does not go beyond close paraphrase.]*
- Ana: I agree with Ana because the money spent on space research should be used to benefit those in need. *[Does not go beyond close paraphrase.]*
- Kate: Because she gives the best arguments. *[Vague]*
- Felix: Felix says that life cannot be sustained on earth, so we need to find another planet to live on. *[Does not go beyond close paraphrase.]*
- Felix – the coolest. *[Vague answer.]*
- Ana – her article is true and it is right. *[Gives no account of main ideas of argument.]*
- Felix because the hole in the ozone layer is a serious problem. *[Focuses on a detail of the argument.]*
- Felix – he is really concerned about the environment. And he is a cool guy who respects nature. *[Does not distinguish Felix's position from Dieter's: they are both concerned about the environment.]*
- Beatrice because I agree that exploring space is important for our future. *[Does not distinguish Beatrice's position from Felix's: they are both in favour of space research and both refer to a long-term view.]*

OR: Shows inaccurate comprehension of the material or gives an implausible or irrelevant answer.

- Beatrice: The human race will not be able to survive on planet earth much longer, so we need to move somewhere else. [Inaccurate account of Beatrice's argument.]
- Kate – she is right because earth will soon run out of resources and then what will we do? [Inaccurate summary of Kate's argument (seems to confuse it with Felix's).]
- Challenge – I like challenges over all. [Irrelevant answer.]

Code 9: Missing

This task requires students to draw on their own knowledge and beliefs to evaluate the arguments put forward by the writers, comparing the substance rather than the form of the texts. In the five-aspect categorisation, this task is therefore classified as reflecting on the content of a text. In order to gain credit for this item, students needed to demonstrate implicitly or explicitly that they understood the main thrust of the argument advanced by their chosen writer, as well as justifying their position, either by introducing their own supporting argument or by summarising or interpreting the argument by the writer.

Full credit was available regardless of which writer was nominated by the student, as long as the criteria outlined above were satisfied. Some typical answers that earned full credit were:

- Ana – I feel that we should take care of what is going on in our own world before we blow all our money on space exploration. I understand the importance of some exploration but I think disease and famine need to be helped out of this world first.
- Dieter – I agree with him because he is concerned with the environment and he thinks that we should leave outer space alone.
- Felix – I agree with Felix because unless we are willing to face extinction, there is no other place to go after we have wrecked the earth.

Answers that were not given credit often quoted from one of the texts without addition, whereas the task directed students to use their own words. Other responses that gained no credit were vague, or offered a general opinion without substantiating it with reference to one of the texts (for example, "Dieter. Let's look at the realities").

Question 7: STUDENT OPINIONS

Some statements are matters of opinion, based on the ideas and values of the writer. Some statements are matters of fact, which may be tested objectively and are either correct or incorrect.

Draw a circle around "matter of opinion" or "matter of fact" next to each of the quotations from the students' writing listed below.

The first one has been done for you.

Quotation from students' writing	Matter of opinion or matter of fact?
"Pollution has caused a hole in the ozone layer." (Felix)	Matter of opinion / (Matter of fact)
"Billions of dollars are poured into space research by large companies each year." (Ana)	Matter of opinion / Matter of fact
"Space exploration strengthens the dangerous belief that human problems can be solved by our ever-increasing domination of the environment." (Dieter)	Matter of opinion / Matter of fact
"Discontinuing space exploration in favour of solving immediate problems is a very narrow-minded and short-term view." (Felix)	Matter of opinion / Matter of fact

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Multiple
Text type	Argumentation
Aspect	Reflect and evaluate: Reflect on and evaluate the form of a text
Question intent	Distinguish fact from opinion
Item format	Complex multiple choice

CODING GUIDE

Quotation from students' writing	Matter of opinion or matter of fact?
"Pollution has caused a hole in the ozone layer." (Felix)	Matter of fact
"Billions of dollars are poured into space research by large companies each year." (Ana)	Matter of fact
"Space exploration strengthens the dangerous belief that human problems can be solved by our ever-increasing domination of the environment." (Dieter)	Matter of opinion
"Discontinuing space exploration in favour of solving immediate problems is a very narrow-minded and short-term view." (Felix)	Matter of opinion

Full Credit

Code 1: 3 correct.

No Credit

Code 0: 2 or fewer correct.

Code 9: Missing.

The ability to distinguish between fact and opinion is an important critical faculty that individuals need to draw on every day in their capacity as citizens and consumers – the more so as the texts that we encounter in both the print and electronic media grow in number and sophistication. This task is designed to assess students' proficiency in this skill, but in a structured format that provides a good deal of support. Firstly, the challenge of the task is constrained by limiting the evaluation to short, clearly identified parts of the five texts. Two of the texts, moreover, contain terms that are clearly recognisable as markers of opinion: "dangerous belief" and "short-term view". Finally, support for each fact/opinion decision is provided through the inclusion of definitions of "matters of opinion" and "matters of fact" in the stem of the question. With this scaffolding, just under three-quarters of the students in the field trial sample were able to categorise correctly all three of the quotations listed in the table.

PRINT READING UNIT 4

Supermarket Notice

Peanut Allergy Alert
Lemon Cream Biscuits

Date of alert: 04 February
Manufacturer's Name: Fine Foods Ltd
Product Information: 125g Lemon Cream Biscuits (Best before 18 June and Best before 01 July)
Details: Some biscuits in these batches may contain pieces of peanut, which are not included in the ingredient list. People with an allergy to peanuts should not eat these biscuits.
Consumer action: If you have bought these biscuits you may return the product to the place of purchase for a full refund.
Or call 1800 034 241 for further information.

This public notice consists of a very short text that has an everyday function: to warn about the possible danger of a product to consumers and to give advice to return the product for a refund. While the formatting of the stimulus reflects the international standard for product recall notices, many students may not have seen this kind of notice. Nevertheless, the content of the warning is clearly set out and a minimum number of words is used. Lemon biscuits were chosen as the product because of their familiarity and likely appeal. In developing very short easy items, the test developers sought to use simple pieces of stimulus with familiar content. This was not only to make the cognitive load of the items lighter, but also to present texts that were unlikely to intimidate students with low reading proficiency, since such readers can easily be discouraged from even attempting to read something that they believe looks too hard or too long. The text format classification of the supermarket notice is non-continuous, as it consists of a list of described features. In terms of text type, the notice is instructional: it provides directions on what to do if you have bought the product.

Question 2: SUPERMARKET NOTICE

What is the purpose of this notice?

A. To advertise Lemon Cream Biscuits.

B. To tell people when the biscuits were made.

C. To warn people about the biscuits.

D. To explain where to buy Lemon Cream Biscuits.

Framework Characteristics

Situation	Public
Medium	Print
Text format	Non-continuous
Text type	Instruction
Aspect	Integrate and interpret: Form a broad understanding
Question intent	Recognise the main idea of a short text by combining adjacent pieces of information
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: C. To warn people about the biscuits.

No Credit

Code 0: Other responses.

Code 9: Missing.

To answer this question correctly, students must form a global understanding of the text to recognise its overall purpose. In particular, to reject distractors A and D, students must recognise that although the text is about a particular product, it is not an advertisement, but a warning. This item was easy. The easiness of this item comes in part from the fact that the whole text is very short.

Question 3: SUPERMARKET NOTICE

What is the name of the company that made the biscuits?

.....

Framework Characteristics

Situation	Public
Medium	Print
Text format	Non-continuous
Text type	Instruction
Aspect	Access and retrieve: Retrieve information
Question intent	Locate a synonymous match in a short text
Item format	Closed constructed response

CODING GUIDE

Full Credit

Code 1: Fine Foods Ltd

No Credit

Code 0: Other responses.

Code 9: Missing.

To answer this question successfully the student needs to locate a single explicitly stated piece of information in the text, using a synonymous match between the task direction and the text (company / manufacturer). The fact that the whole text is very short, and that the needed information is near the beginning of the text, adds to the easiness of the task. The response format for the task is described as closed constructed response, since only one answer (with a small range of variants: Fine Foods or Fine Foods Ltd.) is given full credit.

Question 5: SUPERMARKET NOTICE

What would **you** do if you had bought these biscuits?

.....

Why would you do this?

Use information from the text to support your answer.

.....

.....

Framework Characteristics

Situation	Public
Medium	Print
Text format	Non-continuous
Text type	Instruction
Aspect	Reflect and evaluate: Reflect on and evaluate the content of a text
Question intent	Hypothesise about a personal course of action in response to the information in a text
Item format	Open constructed response

CODING GUIDE

Full Credit

Code 1: 5A: Provides a response that is consistent with an understanding that the biscuits may be returned with a refund. May refer to eating the biscuits, not eating the biscuits, returning them or getting rid of them in some other way AND
5B: Gives an explanation consistent with the text and the response in 5A. Must be consistent with the idea that the peanuts pose a potential threat.

- (5A)
  Ask for my money back.
  (5B)
  It tells me to.
  I'm allergic to peanuts.
  They did something wrong.
  There might be something (else) wrong.
  I don't like peanuts.
- (5A)
  Throw them away.
  (5B)
  I'm allergic to peanuts.
  There might be something wrong.
- (5A)
  Eat them.
  (5B)
  Peanuts won't harm me .
  I'm not allergic to peanuts.
  I like peanuts.
- (5A)
  Give them to my classmate,
- (5B)
  She's not allergic to peanuts.
- (5A)
  Nothing.
  (5B)
  I'm not allergic to peanuts.
  I can't be bothered to go back to the shop.

5A: Quotes from or paraphrases an appropriate section of the text without further explanation (implying that the text tells you what to do and that no further explanation is required).
5B: No response.

- (5A) Return the product to the place of purchase for a full refund. Or call 1800 034 241 for further information.
  (5B) (no response)
- (5A) Return the product to the place of purchase for a full refund.
  (5B) (no response)
- (5A) Call 1800 034 241 for further information.
  (5B) (no response)
- (5A) Call the number for more information.
  (5B) (no response)

5A: No response AND 5B: Gives explanation for taking no action. Must be consistent with the idea that the peanuts pose a potential threat.

- (5A) (no response)
  (5B) I'm not allergic to peanuts.
- (5A) (no response)
  (5B) I can't be bothered to go back to the shop.

No Credit

Code 0: Gives an insufficient or vague response.

- (5A) I don't know
  (5B) they might have peanuts
- (5A) eat them
  (5B) there might be peanuts

Shows inaccurate comprehension of the material or gives an implausible or irrelevant response.

- (5A) (no response)
  (5B) check them for nuts.
- (5A) eat them.
  (5B) they look good enough to eat.
- (5A) give them to someone.
  (5B) it doesn't matter.
- (5A) (no response)
  (5B) I'm allergic to peanuts.
- (5A) (no response)
  (5B) peanuts can be dangerous.
- (5A) throw them away.
  (5B) They're past their Best before date.

Code 9: Missing.

This question requires students to hypothesise about their likely personal response to the information in the text. Since the question requires a judgement based on personal preferences, or likely behaviours, the question is classified as reflect and evaluate. The coding guide indicates that a wide range of responses can receive full credit, so long as the response is consistent with two central ideas of the text: firstly, that it is possible to return the biscuits, and secondly that the biscuits pose a potential threat. The item is easy, with over four-fifths of the field trial respondents gaining full credit. The easiness of the item can be explained in part by the low level of reflection to be done: no specialised knowledge is required in order to explain a personal preference about a course of action regarding the familiar topic of food.

Question 6: SUPERMARKET NOTICE

Why does the notice include "Best before" dates?

.....

.....

Framework Characteristics

Situation	Public
Medium	Print
Text format	Non-continuous
Text type	Instruction
Aspect	Integrate and interpret: Develop an interpretation
Question Intent	Identify the purpose of a conventional feature included in a short text
Item format	Open constructed response

CODING GUIDE

Full Credit

Code 1: Refers to the fact that the Best before dates identify the batches of biscuits that are affected.

- to identify the batch(es).
- so you know which packets have peanuts.

No Credit

Code 0: Refers to when the biscuits should be eaten.

- because that's when you eat them.
- to tell you when to eat the biscuits.
- so you don't keep them too long.
- to tell you when they expire.

Gives an insufficient or vague response.

- it's the date.

Shows inaccurate comprehension of the material or gives an implausible or irrelevant response.

- so you know when the notice is irrelevant.

Code 9: Missing.

This question was answered correctly by less than one-third of students. Given the shortness and simplicity of the text, this illustrates the fact that the characteristics of a text only partly explain the difficulty of an item. The question requires students to identify the purpose of a specified part of the text, namely, the "best before dates". The difficulty of the item comes from the fact that students must focus on the purpose of the feature ***in this particular text****. Students who answer by giving the usual purpose of this feature (that is, to tell the consumer when the product should be used by) do not receive credit for this item. In this respect the full credit response is contrary to expectations, an established marker of item difficulty.*

PRINT READING UNIT 5

The Motorcycle

Have you ever woken up feeling that something was wrong?
It was a day like that for me.
I sat up in bed.
A little later I opened the curtains.
It was terrible weather – the rain was pouring down.
Then I looked down into the yard.
Yes! There it was – the motorcycle.
It was just as wrecked as last night.
And my leg was starting to hurt.

Like the Supermarket Notice, this short, self-contained story was included in order to target students with low reading proficiency. Both the topic and the shortness of this text contribute to its likely appeal. The items that relate to this text focus on the interpretation both of specific parts of the text, and of the overall action of the text (a motorcycle accident and its aftermath), which although strongly implied, is never directly stated. As with all narrative texts, this piece is classified as personal in terms of situation, and as continuous in text format. All items relating to this text functioned well in the field trial. The text was not chosen for inclusion in the main survey because the narrative text type was already well covered by other pieces.

Question 1: THE MOTORCYCLE

Something had happened to the person in the story the night before. What was it?

A. The bad weather had damaged the motorcycle.
B. The bad weather had stopped the person from going outside.
C. The person had bought a new motorcycle.
D. The person had been in a motorcycle accident.

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Integrate and interpret: Develop an interpretation
Question intent	Infer prior events using information in a short story
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: D. The person had been in a motorcycle accident.

No Credit

Code 0: Other responses.

Code 9: Missing.

All three items relating to this text were easy, and this item was the easiest. The item requires students to make an inference about events that happened before the time of the story by using the information that is given in the story. The item stem gives a general statement: students are not directed to the part of the story containing the critical information (the final two lines). However, the fact that the whole text is very short makes it easier for students to locate the information relevant to the task. Having located the relevant information, matching the words "motorcycle", "wrecked" and "hurt" in the text to "motorcycle accident" in the response, is a simple inference.

Question 2: THE MOTORCYCLE

"It was a day like that for me."

What kind of day did this turn out to be?

A. A good day.

B. A bad day.

C. An exciting day.

D. A boring day.

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Integrate and interpret: Develop an interpretation
Question intent	Relate a descriptive phrase to events implied in a very short story
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: B. A bad day.

No Credit

Code 0: Other responses.

Code 9: Missing.

This item was very easy. The item requires students to use their understanding of the whole story to interpret the descriptive phrase "It was a day like that for me". Students who receive full credit for the item recognise that the event implicitly referred to in the story (a motorcycle accident) suggests a bad day. The three incorrect distractors were chosen with about equal frequency. Again, the overall shortness of the text contributes to the easiness of this item, making it accessible even to students of low proficiency.

Question 6: THE MOTORCYCLE

Why does the writer begin the story with a question?

A. Because the writer wants to know the answer.

B. To involve the reader in the story.

C. Because the question is hard to answer.

D. To remind the reader that this kind of experience is rare.

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Reflect and evaluate: Reflect on and evaluate the form of a text
Question intent	Recognise the purpose of beginning a story with a rhetorical question
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: B. To involve the reader in the story.

No Credit

Code 0: Other responses.

Code 9: Missing.

The final item relating to this text was the hardest item in the set, but it was still easy, with over four-fifths of the trial test participants gaining full credit. The item requires students to reflect on the form of the text by recognising the author's purpose in beginning the story with a rhetorical question. To answer this question correctly, students must interpret the rhetorical question both as a literary device and in terms of its specific content. Distractors A and C outline two common purposes of rhetorical questions that are not the purpose of the device in this text. Distractor D relates the rhetorical question to the content of the text, but suggests a position that is opposite to that implied in the text: the story suggests that the kind of experience the writer is having is not rare, but common.

PRINT READING UNIT 6

Tall Buildings

"Tall buildings" is an article from a Norwegian magazine published in 2006.

Figure 1: Tall buildings of the world

Figure 1 shows the number of buildings of at least 30 storeys that have been built, or are under construction This includes buildings that have been proposed since January 2001.

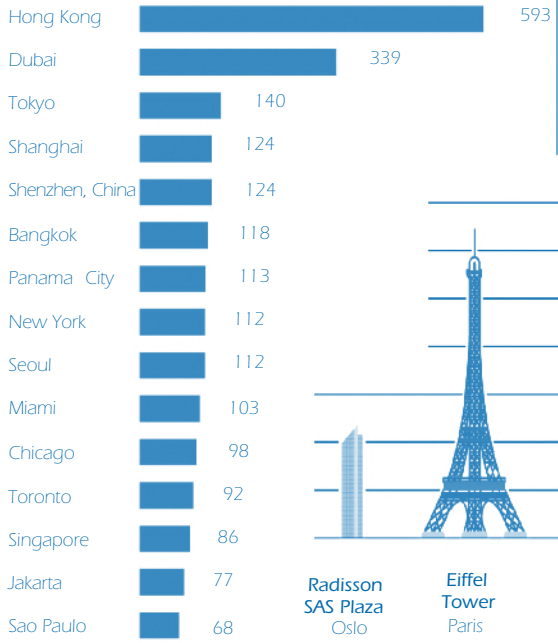
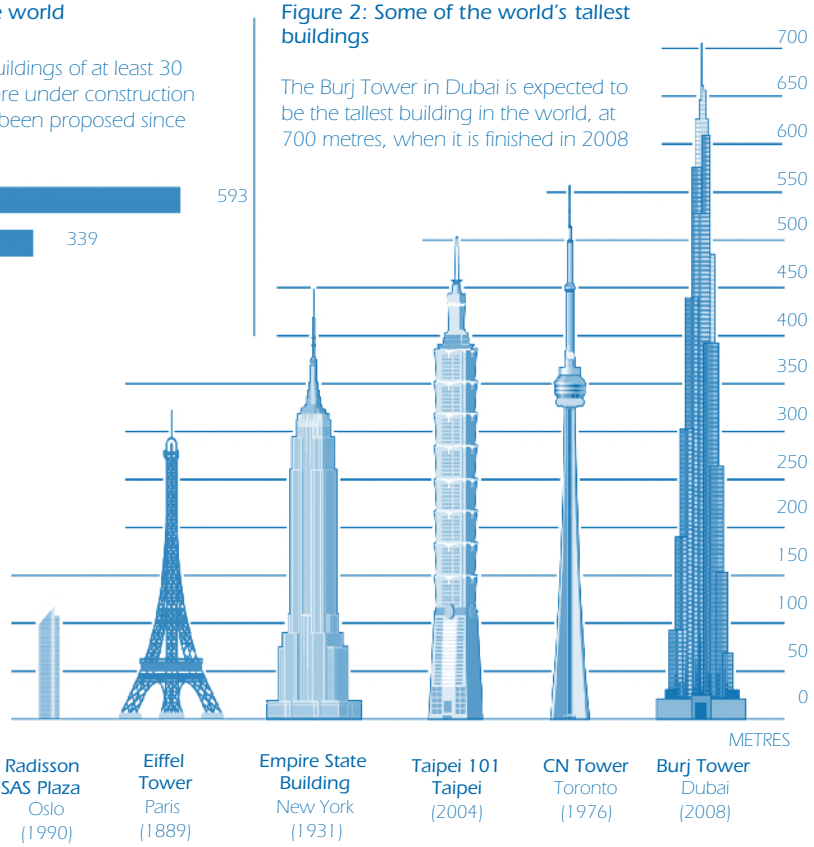


Figure 2: Some of the world's tallest buildings

The Burj Tower in Dubai is expected to be the tallest building in the world, at 700 metres, when it is finished in 2008



This text juxtaposes two figures that are loosely related in terms of their content. Both figures are about tall buildings in the world: Figure 1 shows the number of tall buildings in various cities, proposed or already built, while Figure 2 shows some of the world's tallest buildings. Both Figure 1 and Figure 2 are graphs. Although each figure is introduced by a small piece of explanatory prose, the substantive information of this text is given in the two figures, making the overall text format non-continuous. The text type is description, while the situation of this text is educational, since it appeared in a magazine for students. The piece begins with a brief introduction explaining its context, both in terms of time (the piece was published in 2006) and place (the magazine is Norwegian). One of the reasons why this unit was not chosen for inclusion in the main survey was because of concerns about the ephemeral nature of the material: as more and more tall buildings are built in the world, the material will very quickly become out-dated.

Question 1: TALL BUILDINGS

When the magazine article was published, which of the buildings in Figure 2 was the tallest completed building?

.....

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Non-continuous
Text type	Exposition
Aspect	Access and retrieve: Retrieve information
Question intent	Locate information that is explicitly stated in a graph
Item format	Closed constructed response

CODING GUIDE

Full Credit

Code 1: The CN Tower.

No Credit

Code 0: Other responses.

- The Burj Tower.

Code 9: Missing.

This item was answered correctly by about two-thirds of students. The difficulty in this item comes from the need to integrate information from more than one place in the text. To receive credit, students must connect the information in the question ("when the magazine article was published" and "completed building") with the introduction to Figure 1. This introduction explains that, at the time of the article's publication, the Burj Tower was not yet complete, and so eliminates this apparently plausible option as a correct answer. Students could also arrive at the correct answer by relating the date in the introduction to the unit ("Tall buildings" is an article from a Norwegian magazine published in 2006) to the date given for "Burj Tower" in Figure 2 (2008) to eliminate this as a possible answer. Students who read only "tallest building" in the item stem, and answer by referring to the tallest building in Figure 2 (the Burj Tower), do not receive credit for this item.

Question 4: TALL BUILDINGS

What kind of information does Figure 1 provide?

A. A comparison of the heights of different buildings.

B. The total number of buildings in different cities.

C. The number of buildings above a certain height in various cities.

D. Information about styles of buildings in different cities.

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Non-continuous
Text type	Exposition
Aspect	Integrate and interpret: Form a broad understanding
Question intent	Generalise about the type of information presented in a graph
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: C. The number of buildings above a certain height in various cities.

No Credit

Code 0: Other responses.

Code 9: Missing.

Like the first item in this unit, this item was moderately difficult. It was answered correctly by about two-thirds of students. While the question stem specifically directs students to Figure 1, and the introduction to Figure 1 is a synonymous match with the key, C, about half of those who did not gain credit for the item selected alternative A, which relates to Figure 2.

Question 5: TALL BUILDINGS

The Radisson SAS Plaza in Oslo, Norway is only 117 metres tall. Why has it been included in Figure 2?

.....

.....

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Non-continuous
Text type	Exposition
Aspect	Reflect and evaluate: Reflect on and evaluate the content of a text
Question intent	Recognise the influence of reader's perspective on the way a text is constructed
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: Refers to the fact that the article is from a Norwegian magazine or that the readers are likely to be Norwegian.

- It's from a Norwegian magazine.
- It's written for people in Norway, so it's to give them a sense of perspective.
- To show the people in Norway that they really don't have very tall buildings!

Refers to the SAS Plaza being a point of reference or comparison without referring to Norwegian readers.

- For comparison.
- To have a reference point.
- So you get an understanding of what the scale means.

No Credit

Code 0: Gives an insufficient or vague response.

- 117 metres is still pretty tall.
- Because it is one of the tallest buildings in the world.
- It's 30 or more storeys high.
- It's the tallest building in Norway. [too vague – does not link with the audience of the text]
- Because it's Norwegian. [too vague – does not link with the audience of the text]

Shows inaccurate comprehension of the material or gives an implausible or irrelevant response.

- It's the only one that's a hotel. [true, but not why it is included in this text]
- It's the only one without a spire. [true, but not why it is included in this text]

Code 9: Missing.

This item was difficult. Only about one-quarter of students answered correctly. The coding guide outlines two kinds of answers that would each receive full credit. In the Field Trial, these two kinds of answers were given different codes, but the field trial data showed that there was little difference between the abilities of the groups of students who answered in these two different ways. Therefore if it had been included in the main survey selection, this item would have been coded with a single full credit code as shown here. Both kinds of full credit answer require student to recognise that the purpose for including a specified building in Figure 2 is to give a point of reference to the reader. In the first kind of full credit answer, students do this by relating the information in the introduction (that the article was published in a Norwegian magazine) to the author's decision to include the tallest building in Norway (the Radisson SAS Plaza) in Figure 2. In the second kind of full credit answer, the idea of perspective is expressed in general, rather than specific terms.

Question 9: TALL BUILDINGS

Suppose that information about tall buildings was presented again in an article like this in twenty years' time.

Listed below are two features of the original article. Show whether or not these features are likely to change in twenty years' time, by circling either "Yes" or "No" in the table below.

Feature of Article	Is it likely to change in twenty years?
The title of Figure 2.	Yes / No
The numbers of buildings shown in Figure 1.	Yes / No

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Non-continuous
Text type	Exposition
Aspect	Reflect and evaluate: Reflect on and evaluate the content of a text
Question intent	Distinguish between structural features and content of a set of graphs
Item format	Complex multiple choice

CODING GUIDE

Full Credit

Code 1: Both correct; No, Yes in that order.

No Credit

Code 0: Other responses.

Code 9: Missing.

In this complex multiple-choice item, students are required to make a decision about two elements in the text, in each case choosing the correct response from two options. Students receive full credit only if the correct answer is identified for both elements. The item was easy, with nearly three-quarters of students receiving full credit. This item requires students to draw on their own knowledge and apply it to the text, and is therefore classified as reflect and evaluate. Students must decide whether each of the features listed is stable, or whether it would change over time. The first item in the list refers to part of the conceptual structure of the text. The second is about ephemeral content, the record of a point in time.

PRINT READING UNIT 7

Democracy in Athens

PART A

Thucydides was a historian and military man who lived in the fifth century BC, during the Classical Greek period. He was born in Athens. During the Peloponnesian War (431 BC to 404 BC) between Athens and Sparta he was in command of a fleet whose mission was to protect the city of Amphipolis in Thrace. He failed to reach the city in time. It fell into the hands of Brasidas, the Spartan general, which forced Thucydides into a twenty-year exile. This granted him the opportunity of collecting detailed information from the two warring factions and the possibility of doing research for his work *History of the Peloponnesian War.*

Thucydides is regarded as one of the great historians of Ancient times. He focuses on natural causes and the behaviour of each individual rather than on fate or the intervention of divinities to explain the evolution of History. In his work, facts are not presented as mere anecdotes; rather, they are explained in an attempt to find out the reasons that led the main characters to act as they did. Thucydides' emphasis on the behaviour of individuals is why he sometimes introduces fictitious speeches: these help him explain the motivations of the historical characters.

PART B

Thucydides attributes to Pericles (fifth century BC), the Athenian ruler, the following speech in honour of the soldiers who fell in the first year of the Peloponnesian War.

Our system of government does not copy the laws of neighbouring states; we are rather a pattern to others than imitators ourselves. Our system is called democracy, since its administration depends on the many instead of the few. Our laws afford equal rights to all in their private affairs, whereas the prestige in public life depends on merit rather than on social class.

Social class does not prevent a person from holding any public position either (…). And, at the same time that we do not interfere in private affairs, we do not break the law as regards public matters. We give our obedience to those whom we put in positions of authority, and we obey the laws themselves, especially those which are for the protection of the oppressed, and those unwritten laws which it is an acknowledged shame to break.

Furthermore, we provide plenty of means for the pleasure of the mind. The games and sacrifices we celebrate all the year round, and the elegance of our private places of residence, form a daily source of pleasure that helps to banish any worry; while the many inhabitants of the city draw the produce of the world into Athens, so that to the Athenian the fruits of other countries are as familiar as those of his own.

Democracy in Athens consists of two fairly short but dense texts. The first is classified as expository, although the first paragraph if considered alone could better be described as narration, since it gives an account of when something happened, referring to a sequence of events in a person's life. However, in the context of the whole of Part A, the biographical paragraph serves as an introduction to the more substantial second paragraph, which places Thucydides in the context of ideas, describing his originality as an historian. Part A as a whole, then, provides an explanation of concepts or mental constructs, which is a marker of expository texts.

Part B presents a sample of one of the "fictitious speeches" written by Thucydides that are referred to in Part A. Part B is an argumentative text, words imagined as having been spoken by Pericles in a speech of political persuasion. Part of the challenge of reading the stimulus as a whole is understanding the relationship between the two texts: it is not stated explicitly but can be inferred from the last sentence of Part A and the introduction to Part B. Other features that make this stimulus likely to be relatively difficult for 15-year-olds are its remoteness from their everyday experience, the abstractness of the language and the formal register, particularly of the rendition of Thucydides' writing. On the other hand it is reasonable to suppose that most students at the end of their compulsory schooling are fairly familiar with history as a concept, and some notion – even if not necessarily articulated – of what democracy might be. This assumed background was judged to provide sufficient context for students to approach the Democracy in Athens material.

Question 3: DEMOCRACY IN ATHENS

One purpose of the speech in Part B was to honour soldiers who fell in the first year of the Peloponnesian War.

What was ANOTHER purpose of this speech?

.....

.....

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Multiple
Text type	Exposition
Aspect	Integrate and interpret: Form a broad understanding
Question intent	Identify the purpose of an argumentative text by linking it to its context
Item format	Open constructed response

CODING GUIDE

Full Credit

Code 2: Refers to (political) motivation attributed to Pericles. May refer to: persuading soldiers to continue the struggle; consoling the families of the dead; fostering pride in the citizens of Athens; or stressing the virtues of Athens compared to Sparta or other cities. Response must be plausible and consistent with the text.

- To make people proud of Athens.
- To promote democracy.
- To explain benefits of the Athenian democracy.
- Making people think Athens is still ok, despite the fact that they are in trouble right now.
- To reinforce positive thinking and positive attitudes.
- To rouse the people.
- To promote patriotism.
- To win the next election.
- To get more popular.
- To make people aggressive against Spartans.

Refers to Thucydides' purpose of understanding Pericles' motivation or way of thinking.

- To explain Pericles' motivation/psychology.
- To explain why he did what he did.

Partial Credit

Code 1: Response refers only to explaining how democracy works.

- To introduce democracy.
- To explain democracy to the people.

No Credit

Code 0: Gives an insufficient or vague response.

- To honour the dead soldiers. [Repeats stem.]

Shows inaccurate comprehension of the material or gives an implausible or irrelevant response.

- Athens was the subject of the speech. [purpose not mentioned]
- To make people laugh. [inaccurate]

Code 9: Missing.

Question 4: DEMOCRACY IN ATHENS

Why was Thucydides forced into exile?

A. He was unable to achieve victory for the Athenians at Amphipolis.

B. He took over a fleet in Amphipolis.

C. He collected information from the two warring factions.

D. He deserted the Athenians to fight with the Spartans.

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Continuous
Text type	Exposition
Aspect	Access and retrieve: Retrieve information
Question intent	Locate information that is explicitly stated in a dense text
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: A. He was unable to achieve victory for the Athenians at Amphipolis.

No Credit

Code 0: Other responses.

Code 9: Missing.

This item was moderately difficult. About two-thirds of students answered correctly. While the information required is explicitly stated, the match between the key "He was unable to achieve victory for the Athenians at Amphipolis" and the relevant part of the text is far from synonymous, and students must make connections within the text to retrieve it. To answer correctly, students need to understand both Thucydides' position within the Peloponnesian War (he was Athenian) and his mission during that conflict (to protect the city of Amphipolis). They must then establish the referent for "it" (It fell into the hands of Brasidas, the Spartan general, which forced Thucydides into a twenty-year exile) to identify the causal relationship between the events in the text. Another source of difficulty in this item lies in the fact that it relates to a dense text, containing complex ideas that are likely to be unfamiliar.

This is coded as a partial credit item. To gain full credit, the response needs to identify the purpose of Pericles' speech by linking it to its context, which is partly provided in the expository text as well as more directly by the speech itself and by its introduction. The full credit response thus needs to be underpinned by a full and detailed understanding of both texts, and to use a high level of inference in an unfamiliar context, dealing with some ambiguity (about the authorship of the speech). Responses in this category refer to the political motivation attributed to Pericles, possibly by mentioning such purposes as persuading soldiers to continue the struggle; consoling the families of the dead; fostering pride in the citizens of Athens; or stressing the virtues of Athens compared to Sparta or other cities. Alternatively full credit answers could refer to the more abstract level of meaning implied in Part A: Thucydides' purpose of understanding Pericles' psychology or way of thinking. Full-credit answers do not need to be long or elaborate yet just over a quarter of responses in the field trial were in this category. About one-fifth of participants in the field trial were able to demonstrate a partial understanding of the text, indicating that its substantial content was about democracy but without registering the persuasive intent.

Question 5: DEMOCRACY IN ATHENS

Who wrote the speech in Part B? Refer to the text to support your answer.

.....

.....

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Multiple
Text type	Exposition
Aspect	Integrate and interpret: Develop an interpretation
Question intent	Recognise the relationship between two texts by integrating information provided
Item format	Open constructed response

CODING GUIDE

Full Credit

Code 1: Identifies Thucydides (explicitly or implicitly) as the author of the speech AND refers to Thucydides attributing the speech to Pericles. May paraphrase or quote the text directly.

- Thucydides. It says "Thucydides attributes to Pericles".
- Thucydides. "He sometimes introduces fictitious speeches: these help him explain the motivations of the historical characters."
- It tells you that Thucydides made up speeches for the people he was writing about.

No credit

Code 0: Identifies Thucydides as the author of the speech without explanation.

- Thucydides.
- A historian and military man.

Gives an insufficient or vague response.

- Somebody else. [too vague]

Shows inaccurate comprehension of the material or gives an implausible or irrelevant response.

- Pericles.
- He was writing in the Peloponnesian War.

Code 9: Missing.

This item was very difficult. It was answered correctly by just under one-quarter of students. The answer is unambiguous when one integrates information from the two texts (Part A and Part B), so the text format for this item is multiple. The juxtaposition of the two texts makes it clear that the author of Pericles' speech is Thucydides. This may be deduced by linking the final part of Part A (which explains that Thucydides sometimes introduces fictitious speeches in his attempts to explain the motivations of historical characters) with the introduction to Part B (which begins "Thucydides attributes to Pericles…"). Alternatively, students may focus only on the introduction to Part B, inferring that "attributed" implies an invention (on Thucydides' part). An added difficulty of this task is that to receive credit, students must support their answer by referring to the text. The reference to the text may be in the form of direct quotation, paraphrase or generalisation.

Question 6: DEMOCRACY IN ATHENS

According to the text, what made Thucydides different from the other historians of his time?

A. He wrote about everyday people, not heroes.

B. He used anecdotes rather than mere facts.

C. He explained historical events by referring to their supernatural causes.

D. He focused on what made people act the way they did.

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Continuous
Text type	Exposition
Aspect	Access and retrieve: Retrieve information
Question intent	Locate information that is explicitly stated in a dense text
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: D. He focused on what made people act the way they did.

No Credit

Code 0: Other responses.

Code 9: Missing.

This item was difficult. It was answered correctly by less than one-half of students. While the information required is explicitly stated, it is located in a dense text. A further source of difficulty is that the question does not explicitly direct students to the part of the text containing the answer. Students who answer correctly must locate the correct part of the text by matching "what made Thucydides different" in the stem with "He focuses on…rather than…" in the stimulus. When the correct part of the text is located, students can match "what made people act the way they did" in the item to any one of "behaviour of each individual", "reasons that led the main characters to act as they did" and "motivations of the historical characters" in the text.

Question 7: DEMOCRACY IN ATHENS

Look at this part of the text, from near the end of Part B:

"Furthermore, we provide plenty of means for the pleasure of the mind. The games and sacrifices we celebrate all the year round, and the elegance of our private places of residence, form a daily source of pleasure that helps to banish any worry."

Which of these sentences best summarises this part of the text?

A. The system of government in Athens allows any person to create laws.

B. Entertainment and beauty are part of the good life you can have in Athens.

C. Athenians live in too much luxury and cannot take life seriously.

D. Public and private life are seen as the same thing.

Framework Characteristics

Situation	Educational
Medium	Print
Text format	Continuous
Text type	Argumentation
Aspect	Integrate and interpret: Develop an interpretation
Question intent	Construe a sentence from an argumentative text
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: B. Entertainment and beauty are part of the good life you can have in Athens.

No Credit

Code 0: Other responses.

Code 9: Missing.

This item was moderately difficult. It was answered correctly by less than two-thirds of students. In this item, students are required to interpret a part of the text that is quoted in full in the question stem. The difficulty in this item therefore lies purely in construing the text, since no retrieval of information is required. The part of the text to be interpreted is fairly long and complex, and contains several ideas. Students who answer correctly must negotiate multiple inferences, matching "elegance of our private places" in the text with "beauty" in the stem, as well as "pleasure of the mind" and "games" in the text with "entertainment" in the question.

PRINT READING UNIT 8

Destination Buenos Aires

And so the three mail planes from Patagonia,[1] Chile and Paraguay were returning from the South, the West and the North to Buenos Aires. Their cargo was awaited there so that the plane for Europe could take off, around midnight.

Three pilots, each behind an engine casing heavy as a barge, lost in the night, were contemplating their flight and, approaching the immense city, would descend slowly out of their stormy or calm sky, like strange peasants descending from their mountain.

Rivière, who was responsible for the entire operation, was pacing up and down on the Buenos Aires landing-ground. He remained silent, for until the three planes had arrived, the day held a sense of foreboding for him. Minute by minute, as the telegrams reached him, Rivière was conscious that he was snatching something from fate, gradually reducing the unknown, hauling in his crews out of the night, towards the shore.

One of the men came up to Rivière to give him a radioed message:

Chile mail reports that he can see the lights of Buenos Aires.

Good.

Before long, Rivière would hear this plane; already the night was surrendering one of them, just as a sea, swollen with ebbing and flowing and mysteries, surrenders to the shore the treasure it has tossed around for such a long time. And later on, it would give back the other two.

Then this day's work would be over. Then the worn-out crews would go and sleep, to be replaced by fresh crews. But Rivière would have no rest: the mail from Europe, in its turn, would fill him with apprehension. And so it would always be. Always.

Antoine de Saint-Exupéry, *Vol de Nuit*, © Éditions Gallimard

1. Southern region of Chile and Argentina

Destination Buenos Aires is an extract from Antoine de Saint-Exupéry's 1931 novel *Vol de Nuit* (published in English as Night Flight). The only addition to the original text for its appearance in PISA was an explanatory footnote relating to "Patagonia", as students would certainly have differing levels of familiarity with this place name. The explanation gives context which might help students to negotiate the text. The extract takes place at a landing-ground in Buenos Aires, and is a self-contained portrait of Rivière, a man weighed down by the responsibility of his job. Though the novel was written in 1931, the human themes remain familiar.

Question 3: DESTINATION BUENOS AIRES

How does Rivière feel about his job? Use the text to give a reason to support your answer.

.....

.....

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Integrate and interpret: Develop an interpretation
Question intent	Link information across a narrative to generalise about a character's state of mind, providing evidence to support the generalisation
Item format	Open constructed response

CODING GUIDE

Full Credit

Code 2: Describes Rivière's feeling about his job by referring to stress, persistence, being burdened, or being committed to doing his duty; AND gives an explanation referring to a relevant section of the text. May refer to the text generally, or may paraphrase or quote the text directly. The quotation must match the stated emotion.

- He is overwhelmed by it all, you can see in the last line, he never gets to rest.
- He is stressed. The day has "held a sense of foreboding for him".
- He is weighed down by it. All day he worries about those three planes, then he has to worry about the Europe one!
- He is resigned. You can see from that last "always" that he thinks things will never change.
- He really cares about his job. He can't relax until he knows that everyone is safe. [Includes a general reference to the text.]

Partial Credit

Code 1: Describes Rivière's feeling about his job by referring to stress, persistence, being burdened, or being committed to doing his duty, without an explanation that refers to the text.

- He feels really responsible for the things that happen.
- He's stressed.

No Credit

Code 0: Gives an insufficient or vague response.

Shows inaccurate comprehension of the material or gives an implausible or irrelevant response.

- He likes his job because he is in control of lots of things. [not supported by the text]
- He thinks it is cool because he can watch planes. [not supported by the text]

Code 9: Missing.

The coding guide for this item shows that there are two kinds of response that receive credit. Full credit responses are those which accurately respond to the question and give an explanation using the text. Partial credit responses are those which accurately respond to the question, but fail to give an explanation for the response. The partial credit code recognises that an incomplete answer is superior to an inaccurate one. In the field trial, less than half of the students received full credit for this item, but an additional one quarter received partial credit, meaning that about three-quarters of students received some credit (either full or partial) for this item. This question is classified as integrate and interpret,

because although students are required to generate a response that is not given explicitly in the text, all the information necessary to answer the question is contained within the text.

Question 5: DESTINATION BUENOS AIRES

"Destination Buenos Aires" was written in 1931. Do you think that nowadays Rivière's concerns would be similar? Give a reason for your answer.

.....

.....

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Reflect and evaluate: Reflect on and evaluate the content of a text
Question intent	Hypothesise about the effect on a character of a change in a narrative's context
Item format	Open constructed response

CODING GUIDE

Full Credit

Code 1: Answers (or implies) Yes OR No and refers to a time-based comparison AND supports their answer. May refer to material concerns such as technological progress or improvements in security OR to psychological concerns such as anxiety. Answer must be consistent with an accurate reading of the text.

- Now, pilots (planes) have very sophisticated tools intended for orientation, making up for technical issue when the weather conditions are bad.
- No, nowadays, planes have radars and automatic piloting systems, which can help them to escape from dangerous situations.
- Yes, planes are still dangerous, just like any other means of transport. The risks of crash or engine failure are never eradicated.
- Now, new technologies and technical progress are very important, in the planes as well as on the ground.
- Yes, there is still a risk of crashing.
- No, before, there was no fear of terrorist attacks.

No Credit

Code 0: Gives an insufficient or vague response.

- No, the fears are different today.
- Yes, some progress has been made.
- In a way, yes, but in the modern day context. [vague]
- Over the years, people would have changed it. [vague]

Shows inaccurate comprehension of the material or gives an implausible or irrelevant response.

- No, because you don't travel by night nowadays. *[inaccurate about the world]*
- No, because nowadays, pilots are much better trained. *[irrelevant]*
- No, Rivière is really happy with his job but nowadays there are terrorists to worry about. *[inaccurate reading of the text]*

Code 9: Missing.

This item was moderately difficult. Just over one-half of students answered correctly. The item requires students to reflect on the context in which a text was written and compare that context to their own. The object of the question is to encourage reflection. Therefore, so long as the response is consistent with an accurate reading of the text, and expresses a plausible position about the modern day context, a wide range of responses receive full credit, regardless of the position adopted.

Question 7: DESTINATION BUENOS AIRES

What happens to the main character in this text?

A. He has an unpleasant surprise.

B. He decides to change his job.

C. He waits for something to happen.

D. He learns to listen to others.

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Integrate and interpret: Form a broad understanding
Question intent	Recognise the main action in a narrative text
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: C. He waits for something to happen.

No Credit

Code 0: Other responses.

Code 9: Missing.

This item was easy. About three-quarters of students answered correctly. The item requires students to demonstrate a broad understanding of the text by identifying its main idea. The item requires making links across the text and generalising about its overall action. The easiness of the item comes from the fact that the main idea of the text is implied and reinforced across the whole text.

Question 8: DESTINATION BUENOS AIRES

According to the second last paragraph ("Before long …"), in what way are the night and a sea similar?

A. Both hide what is in them.

B. Both are noisy.

C. Both have been tamed by humans.

D. Both are dangerous to humans.

E. Both are silent.

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Continuous
Text type	Narration
Aspect	Integrate and interpret: Develop an interpretation
Question intent	Understand the point of comparison in a metaphor
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: A. Both hide what is in them.

No Credit

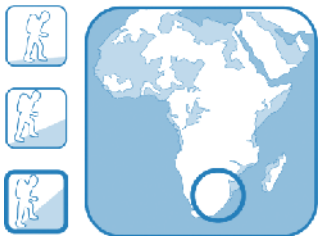
Code 0: Other responses.

Code 9: Missing.

The item requires students to interpret a metaphor, although the word "metaphor" is deliberately avoided in the stem: such metalinguistic terms are likely to vary in familiarity for students from different educational backgrounds, and such metalinguistic knowledge is not part of PISA's description of reading proficiency. On the other hand, the ability to construe figurative language is considered an important constituent of interpreting texts, and particularly literary texts. It is recognised that a particular challenge for an international assessment of reading is to reflect this ability across languages and cultures. In this item, the figurative language in question uses terms ("sea" and "night") that can be regarded as universally familiar, and that have a similar connotation across cultures in the context provided by the narrative passage. The field trial results indicate that the item had robust psychometric qualities and performed similarly across countries and languages. This item demonstrates, then, that it is sometimes possible to successfully construct an item that focuses on a text's literary qualities, such as figurative language, for an international assessment. This question also demonstrates that while it is most common for multiple-choice items in PISA to have four possible response options, sometimes more than four options are given. The item was moderately difficult, with less than two-thirds of students answering it correctly.

PRINT READING UNIT 9

African Trek



The Northern Drakensberg Trek: South Africa / Lesotho

Fact file

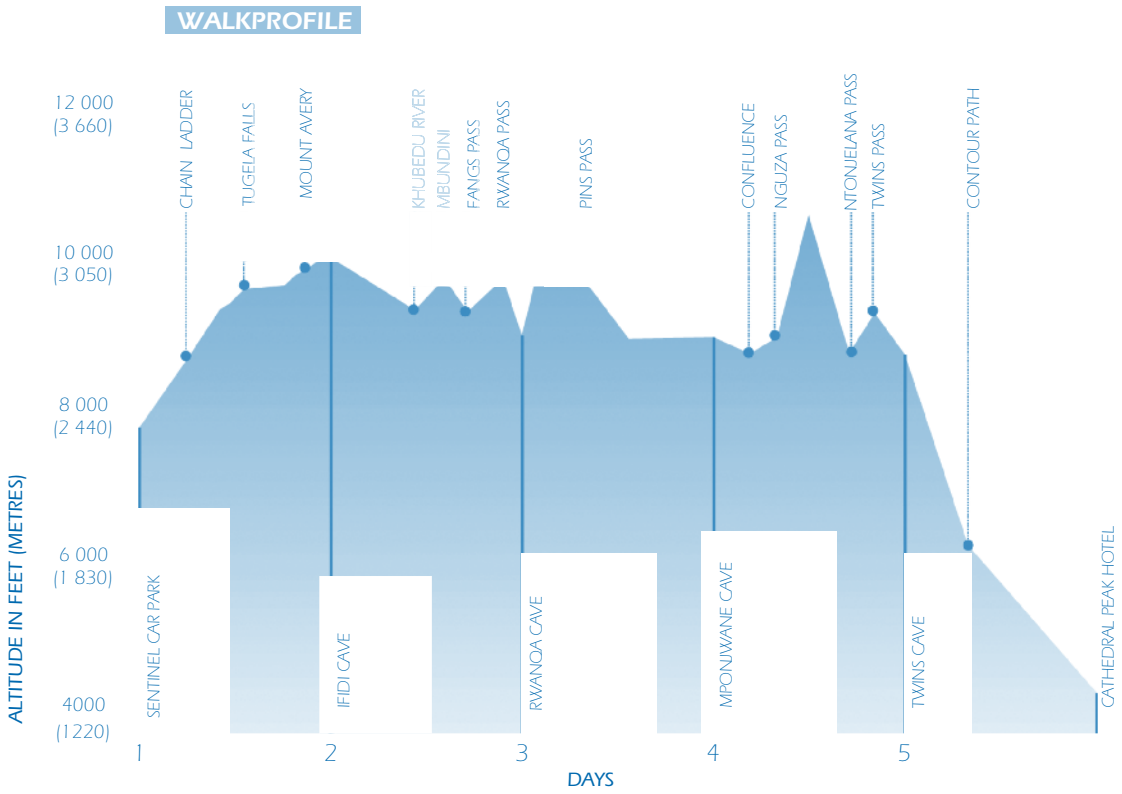
OVERVIEW

- The Northern Drakensberg Trek involves crossing the northern Drakensberg escarpment at high altitudes. The route, which is approximately 40 miles (65km) long, straddles the border between South Africa and Lesotho, taking 5 strenuous days to complete. The Trek is filled with highlights, including breathtaking views over the Amphitheatre to the Devil's Tooth as you make your way to the Chain Ladder, and sunrise seen from Mponjwane, which is well worth setting your alarm for.
- Start: The Sentinel car park, Royal Natal National Park.
- Finish: The Cathedral Peak Hotel.
- Difficulty and Altitude: This is a high-mountain walk in one of the more remote areas of the Drakensberg Range. The going can be quite tough and the days long. Good navigation skills are essential for safe crossing.

TIMING AND SEASONALITY

- Best Months to Visit: April, May, June or September, October, November.
- Climate: Summers in the Drakensberg can be very hot and very wet. The winters are much drier, but there is always a chance of precipitation, which will probably take the form of snow on the high ground. In spring and autumn the daytime temperatures are ideal (between 60°F/15°C and 70°F/20°C), but at night will frequently drop below freezing point.

Temperature and Precipitation												
Average daily maximum temperature												
(°F)	72	70	70	66	63	60	60	63	66	68	70	70
(°C)	22	21	21	19	17	15	15	17	19	20	21	21
Average daily minimum temperature												
(°F)	55	55	54	48	46	41	41	43	46	48	52	54
(°C)	13	13	12	9	8	5	5	6	8	9	11	12
Average monthly precipitation												
(Inches)	9.3	8.5	7.7	3.1	1.1	0.6	0.5	1.3	2.4	4.0	6.5	7.9
(Millimetres)	237	216	196	78	29	14	12	33	62	101	165	201
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC



African Trek is classified as mixed in terms of text format, because it contains both continuous elements (the prose dot points in the overview) and non-continuous elements (the temperature and precipitation table and the walk profile). Since the aim of both the continuous and non-continuous elements of the text is to describe the Northern Drakensberg Trek, the text type is description. In terms of situation, the text is classified as personal, since it is intended to be read by individuals for their own interest and information.

Question 2: AFRICAN TREK

At what altitude is the Sentinel Car Park? Give your answer in feet and metres.

..... feet

..... metres

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Non-continuous
Text type	Description
Aspect	Access and retrieve: Retrieve information
Question intent	Locate information that is explicitly stated in a graphic
Item format	Closed constructed response

CODING GUIDE

Full Credit

Code 1: Answers 8000 (feet) AND 2440 (metres).

No Credit

Code 0: Other responses.

- 8000 metres, 2440 feet.
- 6000 metres, 1830 feet.

Code 9: Missing.

This item was easy. It was answered correctly by nearly three-quarters of students. Although the item is easy, multiple steps are involved in answering correctly. Firstly, the student must locate the part of the text in which the correct answer is found, since the question stem does not direct the student to this part of the text. Once the correct part of the text (the Walk Profile) is located, the student must correctly interpret the key to the Walk Profile to recognise the units for each number, and finally, retrieve the specified information.

Question 7: AFRICAN TREK

According to the information provided, where would you stay after the second day of walking?

A. At the Sentinel Car Park.

B. At Ifidi Cave.

C. At Rwanqa Cave.

D. At Mponjwane Cave.

E. At Twins Cave.

F. At the Cathedral Peak Hotel.

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Non-continuous
Text type	Description
Aspect	Access and retrieve: Retrieve information
Question intent	Locate information that is explicitly displayed in a mixed format descriptive text
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: C. At Rwanqa Cave.

No Credit

Code 0: Other responses.

Code 9: Missing.

This item was difficult. Just over one-third of students answered correctly. The source of difficulty of this item is clearly shown by the pattern of response options chosen: more students chose option B than the correct response, option C. To respond correctly, students must understand that the numbers on the X-axis of the profile that show each day represent the beginning of that day. Following this logic, the place names that appear immediately following each number do not represent the place that walkers stay on that day, but rather where they stay on the night before the day represented by each of the numbers 1 to 5. The many students who incorrectly chose option B located the number 2 in the walk profile, and assumed that the place name appearing closest to this number would represent the place where you would stay on the night of day 2. These students did not fully comprehend the structure of this non-continuous text. This kind of careful reading is challenging, but it is an important reading skill. This multiple-choice item has six response options, in this case because the six options were naturally suggested by the structure of the walk profile, which includes six place names.

Question 8: AFRICAN TREK

Which day of the trek do you think would be the most difficult? Use the information provided to give a reason to support your answer.

.....

.....

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Non-continuous
Text type	Description
Aspect	Reflect and evaluate: Reflect on and evaluate the content of a text
Question intent	Support an opinion using information from a mixed format descriptive text
Item format	Open constructed response

CODING GUIDE

Full Credit

Code 1: Refers to Day 1, Day 2, Day 3, Day 4 OR Day 5 AND gives a reason that is plausible, and consistent with the text. Must refer (explicitly or implicitly) to the text.

- Day 1. It's uphill all the way.
- Day 2. For me, to go up, then down, then up, then down is worse than consistently going up or down.
- Day 3. There's a horrible peak.
- Day 4. That peak looks pretty harsh.
- Day 5. It's downhill all the way.

No Credit

Code 0: Gives a response that does not refer to the text.

- Day 1. You won't be used to it yet. [no reference to the text]
- Day 5. You'd be absolutely exhausted by then! [no reference to the text]

Gives a response with no explanation.

- Day 2. [no explanation]

Gives an insufficient or vague response.

- Day 1. because it would be difficult. [vague]
- Day 3. that's the middle, so it would be the most difficult. [insufficient]

Shows inaccurate comprehension of the material or gives an implausible or irrelevant response.

Code 9: Missing.

Like the first two items in this set, this item focuses on the Walk Profile. It requires students to express a personal preference in relation to that information and to support their preference using information from the text. The need to draw on outside knowledge in expressing a preference means that this item is classified as reflect and evaluate. As in other items that require students to express a preference, so long as the students support their preference with relevant information from the text, any position may be adopted. The item was moderately difficult, with about two-thirds of students answering correctly.

Question 9: AFRICAN TREK

On the morning of which day of the trek would you see the sunrise mentioned in the overview?

A. Day 1.

B. Day 2.

C. Day 3.

D. Day 4.

E. Day 5.

Framework Characteristics

Situation	Personal
Medium	Print
Text format	Mixed
Text type	Description
Aspect	Access and retrieve: Retrieve information
Question intent	Locate information by linking information presented in words with information presented in a graphic in a mixed format descriptive text
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: D. Day 4.

No Credit

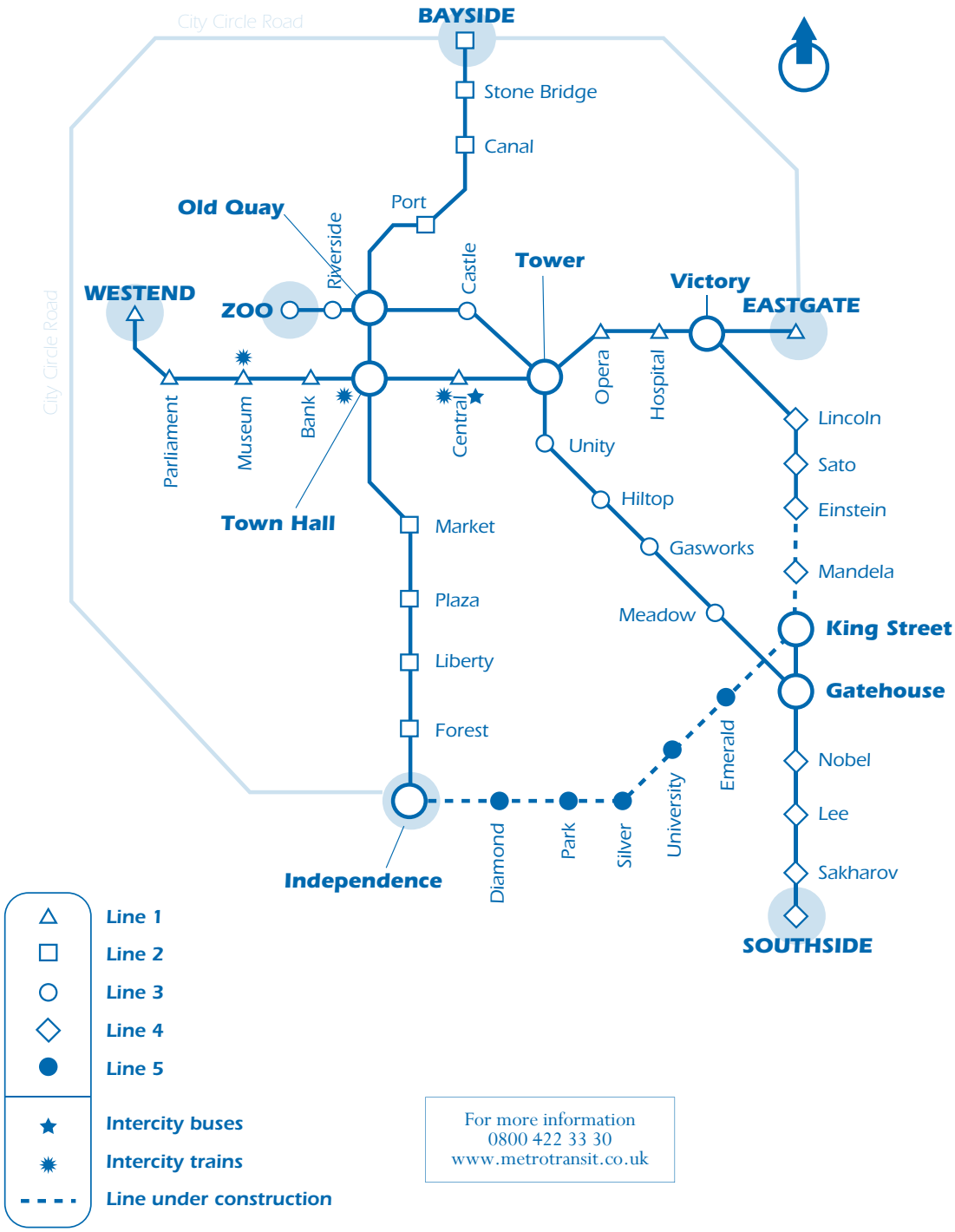
Code 0: Other responses.

Code 9: Missing.

In this item, the information required is contained in the first dot point of the overview and in the Walk Profile. Since students who answer correctly must use information from both the continuous and non-continuous parts of this text, the text format for this item is mixed. This item was moderately difficult. It was answered correctly by less than two-thirds of students. The difficulty in this item comes from the fact that while the end point of the question is to retrieve information that is explicitly stated, students must link information from across the text to successfully retrieve the information required.

PRINT READING UNIT 10

Metrotransit



The Metrotransit unit from the PISA 2009 field trial presents a graphic from a public document, a map of an urban transport network in the form of a diagram. It uses fictional place names that participating countries were invited to adapt for their national versions. The text is non-continuous; it could be presented as a combined list of stations categorised according to line, features and grid locations. Though relatively simple, it includes a complicating element – a key of symbols – the application of which is required to gain full credit for the question reproduced below. All items related to this unit functioned well in the field trial. The unit was not included in the main survey selection because of concern that students living in rural areas, who would be unfamiliar with urban transport networks, might be disadvantaged.

Question 1: METROTRANSIT

From which Metrotransit station is it possible to take both intercity buses and intercity trains?

.....

Framework Characteristics

Situation	Public
Medium	Print
Text format	Non-continuous
Text type	Description
Aspect	Access and retrieve: Retrieve information
Question intent	Locate information by making links across a map
Item format	Closed constructed response

CODING GUIDE

Full Credit

Code 1: Refers explicitly to Central Station. May mention the line.

- Central Station.
- Central.
- Central (Eastgate).
- Central (Line 1).

No Credit

Code 0: Other responses.

- At the station.
- Tower.
- Line 1.

Code 9: Missing.

This kind of authentic task exemplifies PISA's emphasis on using reading for practical purposes in everyday life. The item requires students to interpret the map key and apply it to the map to determine which station meets the criteria specified in the question. Only one station within the map meets the criteria. The coding guide shows that so long as the correct station is unambiguously identified, responses may be expressed in a variety of ways. This item was easy. It was answered correctly by over three-quarters of students.

Question 2: METROTRANSIT

If you are at Zoo Station and you want to go to Stone Bridge Station, at which station would you change lines?

A. Town Hall.

B. Riverside.

C. Bayside.

D. Old Quay.

Framework Characteristics

Situation	Public
Medium	Print
Text format	Non-continuous
Text type	Description
Aspect	Access and retrieve: Retrieve information
Question intent	Identify a junction on a map where there is some competing information
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: D. Old Quay.

No Credit

Code 0: Other responses.

Code 9: Missing.

This question is another example of an authentic task. The item requires students to locate a specified route on the map and in doing so, to determine the point at which it would be necessary to change lines. Once the two specified stations have been located, determining the junction in the short route, which involves only two of the lines, is a simple task. Over three-quarters of students gained credit for this item.

Question 3: METROTRANSIT

Some stations like Westend, Zoo and Independence have grey shading around them. What does the shading show about these stations?

.....

Framework Characteristics

Situation	Public
Medium	Print
Text format	Non-continuous
Text type	Description
Aspect	Reflect and evaluate: Reflect on and evaluate the form of a text
Question intent	Identify the purpose of a graphical feature in a map
Item format	Short response

CODING GUIDE

Question intent

Full Credit

Code 1: Refers to the fact that these stations are at the end or the start of a line.

- End of the line.
- Terminus.

No Credit

Code 0: Gives an insufficient or vague response.

Shows inaccurate comprehension of the material or gives an implausible or irrelevant response.

- You can get buses there. [possibly, but not what the shading shows]
- They are the busiest stations.
- They are the biggest stations.

Code 9: Missing.

This item was moderately difficult. It was answered correctly by less than two-thirds of students. The item requires students to examine a graphical feature (shading) that is common to several stations on the map and in doing so, to determine what the shading is intended to represent in the map. The difficulty of this question lies in the requirement to generalise about the purpose of a feature. Since this question requires students to stand outside the text and consider the way in which it was constructed, the question is classified as reflect on and evaluate the form of a text.

Question 4: METROTRANSIT

You need to find the shortest route by underground rail from Sato Station to Forest Station.

Draw on the map the route that you would take.

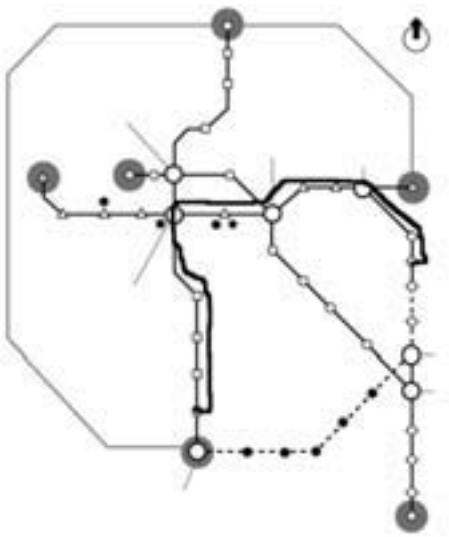
Framework Characteristics

Situation	Public
Medium	Print
Text format	Non-continuous
Text type	Description
Aspect	Access and retrieve: Retrieve information
Question intent	Combine several pieces of information on a map to determine the shortest route between two given points
Item format	Short response

Coding guide

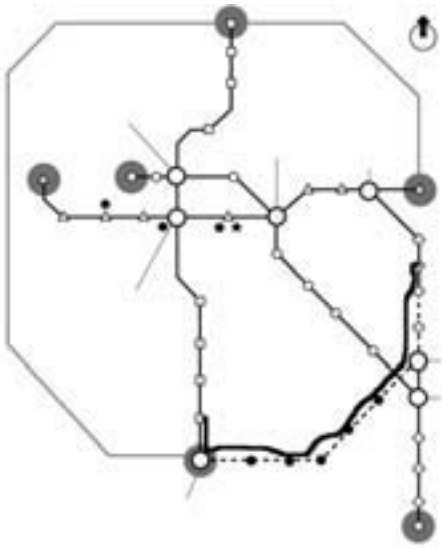
Full Credit

Code 2: Draws the route shown in the reproduction below:



Partial Credit

Code 1: Draws the route shown in the reproduction below:



No Credit

Code 0: Other responses.

Code 9: Missing.

This access and retrieve task requires students to locate and sequence multiple pieces of information – the names of stations – to plan a route. The task simulates a real-life experience that demands careful reading of a non-continuous text. The item was constructed to ensure that use of conditional information – that is, information external to the main part of a text – must be processed in order to complete the task successfully. For full credit, students therefore need to use the information provided in the key: that part of the system is under construction. Students who take account of this conditional information realise that what is apparently the shortest route is currently unusable. The requirement to use conditional information increases the difficulty of items significantly. Only about one-third of students in the field trial gained full credit for this item. However more than half of the other students, who plotted a route using stations on Line 5, were given partial credit, as they demonstrated that in all but one respect (albeit a crucial one in practical terms) they had understood and could use information that they had retrieved.

Most of the items in PISA print reading require a multiple-choice or text response. The short response format of this question, involving the drawing of a route on a map, illustrates that the range of response types can nevertheless vary to some extent, according to the format that seems most appropriate for the particular task. This is bounded, of course, by the practical limitations of a large-scale paper and pen test.

ANNEX A2

Electronic reading sample tasks

The electronic reading sample tasks are examples of questions students answered in the PISA 2009 survey to assess their competencies in reading electronic texts. This part of the survey was optional.

All electronic sample tasks may be viewed on the website for publicly released items of the PISA electronic reading assessment: *http://erasq.acer.edu.au*.

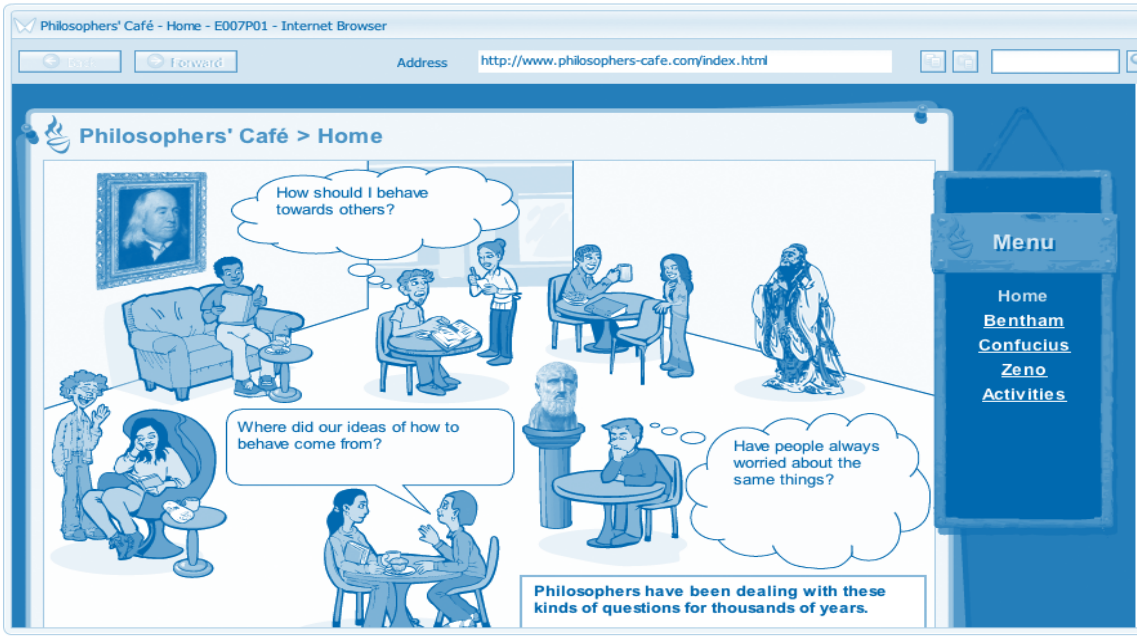
username: public
password: access

Note that the images of the electronic reading assessment stimuli are multicoloured. The true colours as presented on the screen are therefore not reflected in this publication.

PISA 2009 ASSESSMENT FRAMEWORK – KEY COMPETENCIES IN READING, MATHEMATICS AND SCIENCE – ISBN 978-92-64-05960-3

ELECTRONIC READING UNIT 1

Philosophers' Café



This unit is based on the idea of a Web Quest, a type of website that typically involves teaching and learning activities, including tasks and resources. It therefore fits into the educational context. The stimulus for Philosophers' Café includes encyclopaedia-style entries on philosophy loosely related to the notion of the good life, in a way intended to exploit the visual and interactive possibilities of the ERA environment. The screen shot above shows the Home page for the Philosophers' Café. On the right is a menu with links to information about three philosophers, Zeno, Confucius and Bentham, as well as to a series of activities. The central part of the screen shows a café scene populated by young people. It includes thought bubbles with philosophical questions that visitors to the café (or students of philosophy) might be considering. It also includes images of the three philosophers, Zeno, Confucius and Bentham. Each of the images of philosophers has a hyperlink to the same page of information as the matching menu item to the right.

The screen shot below shows the page that can be accessed by clicking on the menu item Confucius, or on the image of Confucius in the top right of the café scene. There are similar pages for Zeno and Bentham. Each text presents some historical context for the philosopher, and one of his central ideas. It is expected that some students would be familiar with the names of one or more of the philosophers, but that they would not necessarily know much about his life or beliefs. The context is thus likely to be unfamiliar, while the subject matter is considered to be complex, since it deals with highly abstract ideas developed in the past, sometimes a very distant past.

Task 1: PHILOSOPHERS' CAFÉ

You are at the Philosophers' Café Home page. Click on the link for Confucius. What did Confucius mean by "Ren"?

A Peace and prosperity.

B Living in chaos and war.

C The behaviour of rulers.

D Kindness to other people.

E Living in harmony.

Framework Characteristics

Situation	Educational
Medium	Electronic
Environment	Authored
Text format	Multiple
Text type	Exposition / description
Aspect	Access and retrieve: Retrieve information
Question intent	Locate a definition that is directly stated in a short text containing complex or unfamiliar information
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: D. Kindness to other people.

No Credit

Code 0: Other responses.

Code 9: Missing.

About two-thirds of the students in the field trial gained full credit for this task. Both the navigation and text processing demands are low. The task requires students to follow the explicit instruction to click on one of the links (either the name "Confucius" or his image in the café scene) in order to open the page describing Confucius. The information required is explicitly stated in the text. Students can read to the end of the text to find the term "Ren" contained in the stem, then make a match between the "kindness" in the text and in the key.

Task 2: PHILOSOPHERS' CAFÉ

Go to the Activities page. Look at Scenario 2. Which of Zeno's teachings does this comic illustrate?

A We should consider others in order to live happily.

B We should be concerned about our appearance.

C We should not let our desires control us.

D We should not try to change the past.

Framework Characteristics

Situation	Educational
Medium	Electronic
Environment	Authored
Text format	Multiple
Text type	Exposition / description
Aspect	Integrate and interpret: Develop an interpretation
Question intent	Recognise a similarity of theme between a complex abstract text and a cartoon
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: C. We should not let our desires control us.

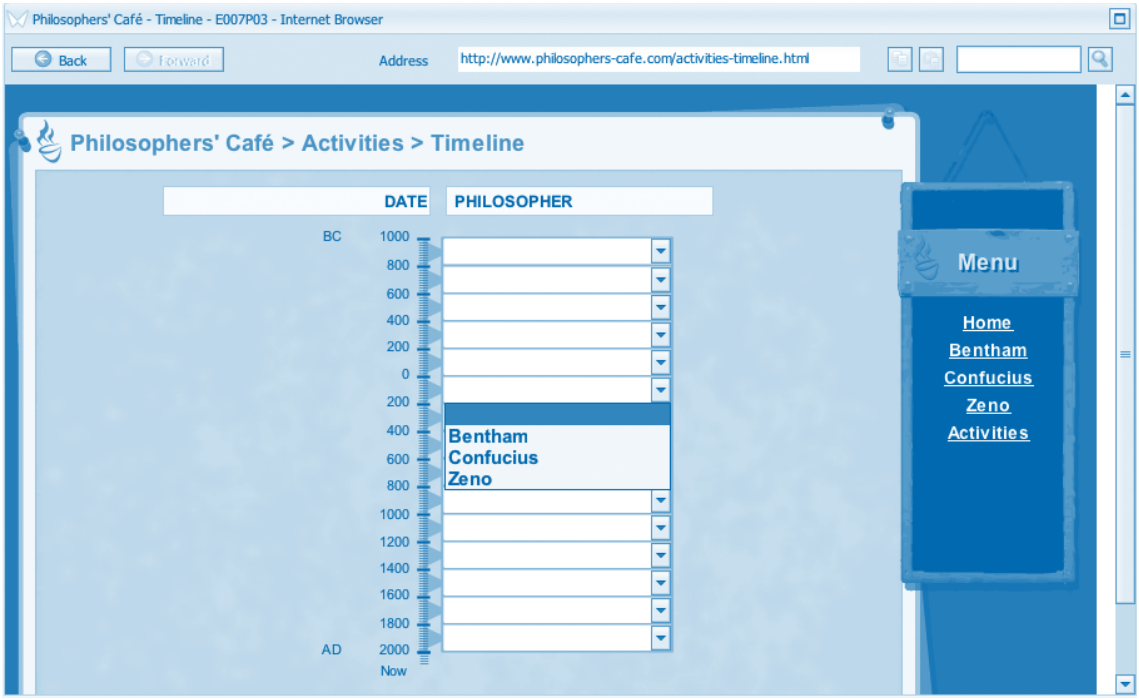
No Credit

Code 0: Other responses.

Code 9: Missing.

This task requires integration of information from two very different texts. Directed by explicit navigation instructions, students follow two links to locate a page with a comic strip. They have to interpret the meaning expressed in the comic strip and relate it to an idea described on the page for the philosopher, Zeno. Navigation is more complex than in task 1, as they need to visit three pages other than the starting page. They will very likely need to go back to the comic strip at least once to check their answer, either (most efficiently) by clicking on the "back" button, or by using the menu links on the right of each page. The options in the four multiple choice alternatives present four possible attitudes, only the final two of which include ideas attributed to Zeno in the text. The last of the alternatives, however, does not offer a plausible interpretation of the comic. Students who chose one of the first two options would quite likely have interpreted them in relation to the ideas expressed in the comic strip only, without reference to Zeno. The task thus combines a number of fairly explicit navigation steps with a requirement to interpret and integrate information across two texts. This combination of demands helps to explain why this item was more difficult than the first task, with about half of the students gaining full credit.

Task 3: PHILOSOPHERS' CAFÉ



Go to the Activities page. Find the Timeline. Use the information in the website to find when each of the three philosophers (Bentham, Confucius and Zeno) was born. Then use the drop down menus in the timeline to show when each philosopher was born.

Framework Characteristics

Situation	Educational
Medium	Electronic
Environment	Authored
Text format	Multiple
Text type	Exposition / description
Aspect	Access and retrieve: Retrieve information
Question intent	Locate several pieces of information that are explicitly stated across multiple sites
Item format	Complex multiple choice

CODING GUIDE

Full Credit

Code 1: Selects correct dates for all three philosophers.

- Confucius: 600 – 400 BC
- Zeno: 400 – 200 BC
- Bentham: 1600 – 1800 AD

No Credit

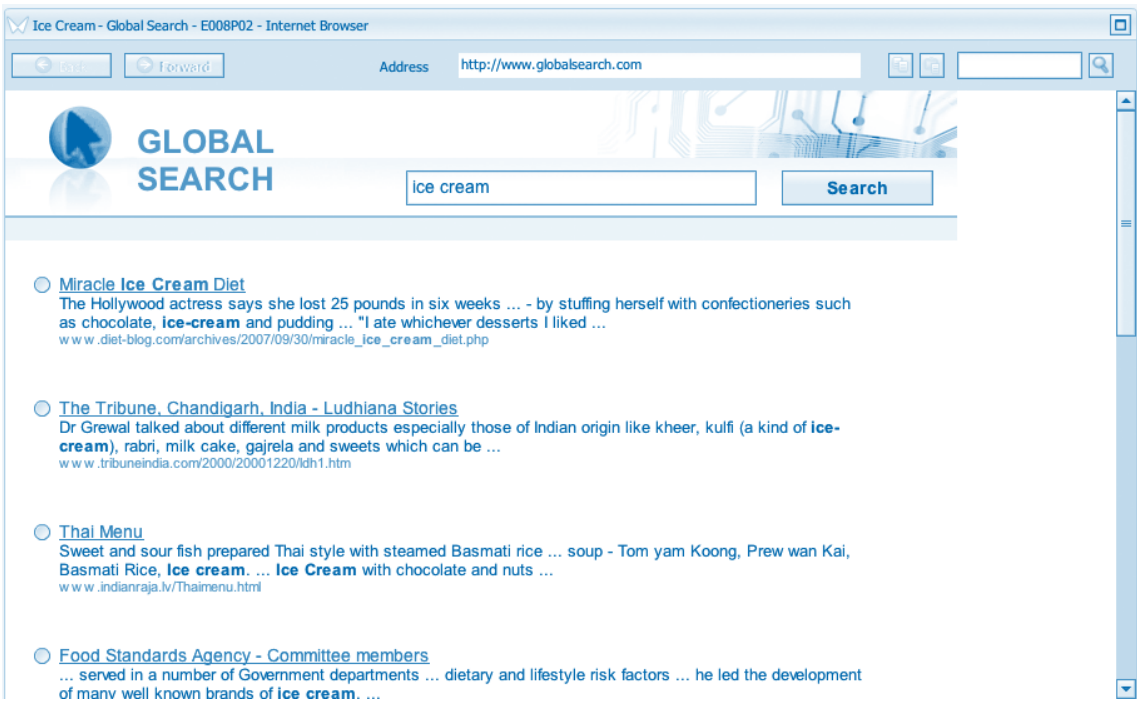
Code 0: Other answers.

Code 9: Missing.

This task asks students to place the three philosophers in chronological history, on a timeline that runs from 1000 BC to 2000AD, with the present day shown as "Now". Students respond within the simulated website, rather than in the task area at the bottom of the screen. The task requires a minimum of six navigation steps, imposing a relatively high navigational demand compared to the difficulty of the text processing required. It requires students to follow two explicitly described links in order to find the timeline where they respond. They then go to the pages for each of the three philosophers and locate the dates when each one lived. These are explicitly and prominently stated in the texts, and cover a lengthy time span, from Confucius (551 to 479 BC) and Zeno (333 BC to about 264 BC) to Bentham (1749 to 1832 AD). There are 15 drop-down menus available, each covering a period of 200 years, from which students need to select the three that correspond to the times when the philosophers lived. If they wish to change their answers, they can reset any individual drop-down menu to be blank.

ELECTRONIC READING UNIT 2

Ice Cream



The stimulus for this unit is a set of internet search results, similar to those obtained using a typical search engine. It thus represents the kind of information commonly seen in daily life, whether at school, at home or in a work context. The results presented vary substantially in both their sources and the kinds of information they include. Although search results are typically generated on the basis of terms selected by an individual, the types of information included in the results tend to be very broad. The majority of the sites referred to in the results are government, commercial and news websites rather than those with a personal focus. To take account of this diversity of content this stimulus is categorised as being in the public category. The topic chosen, ice cream, is considered to be very familiar to students.

The screen shot above shows what readers see when they begin the unit. The full stimulus consists of a single page of ten search results, of which only the first four are initially visible. The reader needs to scroll down to see the full set. The number of search results included in the stimulus thus entails some navigation in order to complete the tasks, and also provides what, from an assessment perspective, can be regarded as a large number of multiple-choice distractors.

Task 1: ICE CREAM

This page shows search results for ice cream and similar foods from around the world. Which search result is most likely to provide a history of ice cream? Click the button next to the link.

Framework Characteristics

Situation	Public
Medium	Electronic
Environment	Authored
Text format	Non-continuous
Text type	Description
Aspect	Integrate and interpret: Form a broad understanding
Question intent	Identify relevant search result by recognising the main theme of a short description
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: Ice Cream – Online Encyclopaedia Article about Ice Cream.

No Credit

Code 0: Other answers.

Code 9: Missing.

This question asks students to select which of the series of results is most likely to provide information of a specific kind. It asks them to form a broad understanding of the likely content of the links in each search result, rejecting those nine results that are irrelevant to their needs, and identifying the only relevant result. This is the kind of operation needed every time a person uses an internet search engine and examines a page of search results. Since the stimulus is on a single page, the only navigation demand is scrolling. The key terms in the questions are "ice cream" (the subject of all the results) and "history". The first nine results provide links to information about ice cream recipes or menus (from India, Latvia, Ireland and Turkey), a personal blog referring to a Hollywood actress, technical information on ice cream, and the page for members of a government agency; all of these can be rejected as unlikely to give a history of ice cream. To gain credit, students need to recognise that expressions in the final result, "the Chinese invented", "oldest evidence in Europe", "the early 20th century" and "One of the oldest types of ice cream", collectively refer to the history of ice cream, and suggest that this link would provide more information on this topic.

The navigation demand is low compared to the demand imposed by the need to obtain a general understanding of each search result. The item was moderate in difficulty, with between half and two-thirds of students gaining full credit.

Task 2: ICE CREAM

This page shows search results for ice cream and similar foods from around the world. You want to know if ice cream can be part of a healthy diet. Which search result is most likely to give accurate advice? Click the button next to the link.

Framework Characteristics

Situation	Public
Medium	Electronic
Environment	Authored
Text format	Non-continuous
Text type	Description
Aspect	Reflect and evaluate: Reflect on and evaluate content of text
Question intent	Evaluate search results in terms of relevance and credibility/ trustworthiness of information
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: National Food Information Centre: The Food Guidelines-Food Label Connection.

No Credit

Code 0: Other answers.

Code 9: Missing.

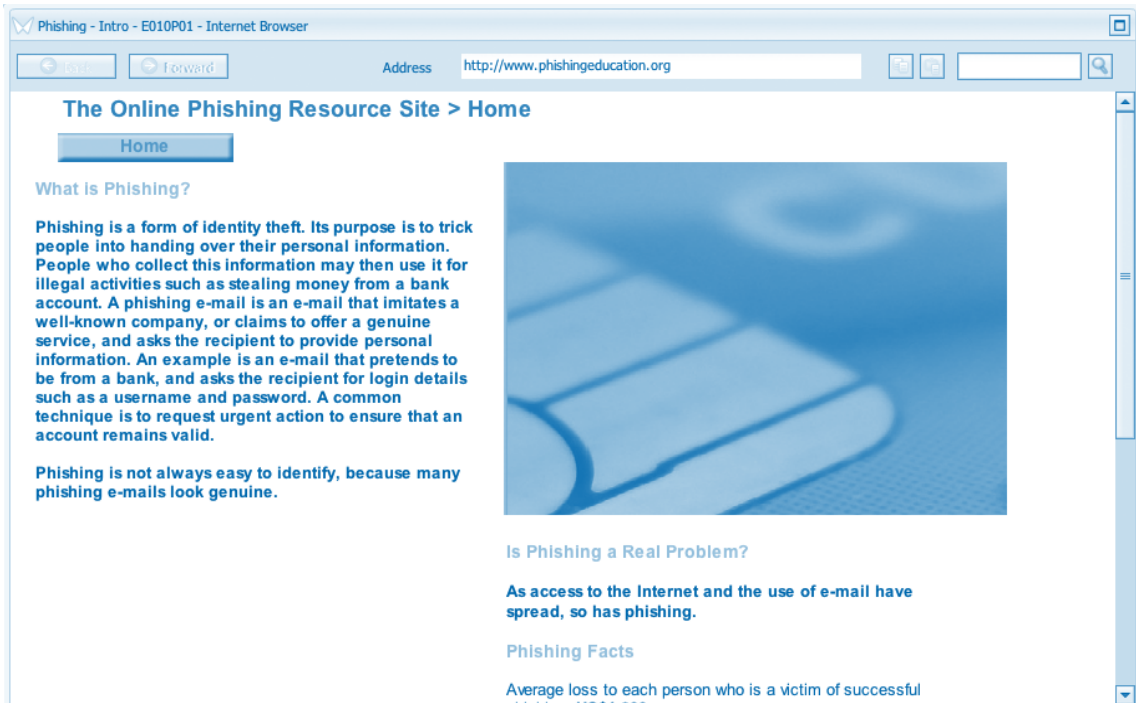
This question represents another very typical task faced by users of the Internet, that is, evaluating the trustworthiness of the results for a particular purpose, in this case the quality of advice about whether or not ice cream may be part of a healthy diet.

In order to gain credit for this task, students need to evaluate the various links in terms of both relevance and likely authoritativeness. This process should lead them to reject results which provide links to recipes and menus, which are not relevant to the focus of the research question referred to in the stem. They must also reject results that refer to diet but that lack authoritativeness, such as the blog referring to the Hollywood actress "stuffing herself with confectioneries"; and results which have some reference to potentially credible sources, but are not likely to be relevant, such as Dr Grewal describing varieties of milk products. Possibly the strongest distractor is the result for the Food Standards Agency, which has a name that sounds both relevant and credible and includes the words "dietary and lifestyle risk factors". However, this search result refers only to committee members of this agency, not to health guidelines. Students need to recognise that the fifth result links to a plausibly reliable national organisation, "National Food Information Centre", and contains not only relevant information on diet recommendations but also the kind of technical language one would expect from a reputable organisation of this kind, such as "serving size" and "National Dietary Guidelines suggest you eat a diet providing 30 per cent or less of calories (joules)".

This reflection and evaluation task, which relies heavily on text processing and little on navigation, was difficult for students in the field trial, with only about one-third selecting the correct search result.

ELECTRONIC READING UNIT 3

Phishing



The material presented in this unit deals with a common problem that arises from living in a technology-rich environment: phishing, the attempt to trick people into providing personal information about themselves, so that it may be used for criminal gain. The stimulus, entitled "The Online Phishing Resource Site", is based on authentic websites that explain this problem, giving suggestions to readers about how to identify phishing and how to avoid becoming a victim of phishing. The home page, an extract of which is shown in the screen shot above, explains what phishing is and provides some background information about the extent of the problem. It is classified as a public text, in that it relates to activities and concerns of the larger society (though it may have a personal application). As a kind of online public notice, it assumes anonymous contact with the reader.

Task 1: PHISHING

You are at the Home page of the Online Phishing Resource Site. According to the information on this page, which one of the following is a feature of a phishing e-mail?

A It asks for personal information.

B It contains unwanted advertising.

C It offers a genuine service.

D It comes from a well-known company.

Framework Characteristics

Situation	Public
Medium	Electronic
Environment	Authored
Text format	Continuous
Text type	Exposition
Aspect	Access and retrieve: Retrieve Information
Question intent	Locate an important component of an explicitly stated definition
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: A. It asks for personal information.

No Credit

Code 0: Other responses.

Code 9: Missing.

No navigation is required for this task, as the paragraph with all the target information appears on the screen when students begin the unit, so the level of difficulty is driven entirely by text processing. To answer this question students need to identify that the wording of the key, "asks for personal information", is a paraphrase of the idea stated in the second sentence of the definition on phishing, "Its purpose is to trick people into handing over their personal information". The distractors include a common misperception ("unwanted advertising" is a common feature of the Internet) as well as ideas referred to in the text but which are features of legitimate e-mails, rather than of attempts at phishing. About two-thirds of students gained full credit for this task.

Task 2: PHISHING

How many phishing e-mails are sent around the world in an average month?

A 1,200.

B Over 6 billion.

C About 25,000.

D 55,000.

Framework Characteristics

Situation	Public
Medium	Electronic
Environment	Authored
Text format	Continuous
Text type	Exposition
Aspect	Access and retrieve: Retrieve information
Question intent	Identify the reference of a number in a list
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: B. Over 6 billion.

No Credit

Code 0: Other responses.

Code 9: Missing.

This task uses the same page of stimulus as the first task, but in contrast to that task, this one does make a minimal navigation demand, as students have to scroll down a short way in order to reveal the four facts about phishing under the heading "Is Phishing a Real Problem", each of which includes one of the numbers in the four options for this question. Students are cued to the need to scroll down because the bottom of the screen they first see contains only part of a sentence. There is a further cue to the relevance of this section of the text in the word "average", which occurs in both the question stem and in the text, "Average loss to each person …". Very little text processing is required to identify the answer, which is explicitly stated in the sentence, "Phishing e-mails sent world-wide each month: **over 6 billion**".

This question was easier than the previous one, with almost three-quarters of students gaining credit for it.

This task starts on a different page of the phishing website from the first two tasks. The new page gives examples of what different features of phishing e-mail messages may look like. As the screen shot above shows, on the left of the page are links that allow readers to read more or to hide additional information about typical features of phishing e-mail messages, under numbered headings. This represents a different kind of navigation to both scrolling and clicking on links that open new pages, since the additional information appears (or can be hidden) on the same page. In this screen shot the user has clicked on "#4. Links in an E-mail", thereby displaying the explanatory paragraph below; and an example of this feature is highlighted in colour at the bottom of the e-mail on the right, *"https://web.BankNorthside.com.au/signin/citifi/scripts/e-mail_verify.jsp"*.

To answer this question, students need to click on one or more of these numbered links, until they locate a match between the question and the information under heading #4. Both navigation and text processing demands are relatively low, although not insignificant, and nearly two-thirds of students obtained full credit for this task.

Task 3: PHISHING

Which of the following tricks is explained on the "Recognising Phishing" page?

A The e-mail asks the recipient to donate money to a fake charity.

B The phishing e-mail installs spyware on the user's computer.

C The author of the e-mail inserts a fake link to a fake website.

E The e-mail pretends the recipient has won a prize.

Framework Characteristics

Situation	Public
Medium	Electronic
Environment	Authored
Text format	Continuous
Text type	Exposition
Aspect	Access and retrieve (retrieve information)
Question intent	Locate explicitly stated information
Item format	Multiple choice

CODING GUIDE

Full Credit

Code 1: C. The author of the e-mail inserts a fake link to a fake website.

No Credit

Code 0: Other responses.

Code 9: Missing.

ANNEX B

Background questionnaires

Annex B provides the background questionnaires used in the PISA 2009 survey to obtain information about the participating schools, students and parents. There are different questionnaires for each group:

The school questionnaire is administered to principals and covers the structure and organisation of the school; the student and teacher body; the school's resources; the school's instruction, curriculum and assessment; the school climate; the school's policies and practices; and the characteristics of the principal or designate.

The questionnaire for students addresses their educational career; family context and home resources; individual engagement in reading; instructional time, learning and assessment; classroom and school climate; access to and use of libraries; and students' strategies in reading and understanding texts.

Two optional questionnaires are administered to students: an educational career questionnaire covering the students' educational histories and career aspirations; and a questionnaire about students' access to information and communication technology and their use of and attitude towards computers.

A third optional questionnaire for parents covers their children's past reading engagement; their own reading engagement; home reading resources and support; parents' background; their perception of and involvement in school; and school choice.

SCHOOL QUESTIONNAIRE

The school questionnaire is administered to the school principal and takes about 30 minutes to complete. It covers a variety of school-related aspects:

- the structure and organisation of the school
- the student and teacher body
- the school's resources
- the school's instruction, curriculum and assessment
- the school climate
- the school policies and practices
- the characteristics of the principal or designate

Technical terms are given in <brackets> and are adapted to the national context by the national data collection centre of the participating country or economy. In this annex, an explanation of the technical terms is given below the questionnaire item.

The structure and organisation of the school

Grade levels

Q1 **Do you have the following grade levels in your school?**
(Please tick one box in each row)

		Yes	No
a)	<Grade 1>	☐ 1	☐ 2
b)	<Grade 2>	☐ 1	☐ 2
c)	<Grade 3>	☐ 1	☐ 2
d)	<Grade 4>	☐ 1	☐ 2
e)	<Grade 5>	☐ 1	☐ 2
f)	<Grade 6>	☐ 1	☐ 2
g)	<Grade 7>	☐ 1	☐ 2
h)	<Grade 8>	☐ 1	☐ 2
i)	<Grade 9>	☐ 1	☐ 2
j)	<Grade 10>	☐ 1	☐ 2
k)	<Grade 11>	☐ 1	☐ 2
l)	<Grade 12>	☐ 1	☐ 2
m)	<Grade 13>	☐ 1	☐ 2
n)	<Ungraded school>	☐ 1	☐ 2

Note.

<Grade> - refers to the administrative level of the student in the school. <Grade 1> is the first year of the primary level of education, when systematic studies characteristic of primary education begin, *e.g.* in reading, writing and mathematics. <Grade 2> is the year immediately following <Grade 1>, etc.
<Ungraded school> is a school, or a study programme within a school, where there are no grades.

Public or private

Q2 **Is your school a public or a private school?**
(Please tick only one box)

A public school
(This is a school managed directly or indirectly by a public education authority, government agency, or governing board appointed by government or elected by public franchise.) ☐1

A private school
(This is a school managed directly or indirectly by a non-government organisation; e.g. a church, trade union, business, or other private institution.) ☐2

School funding sources

Q3 **About what percentage of your total funding for a typical school year comes from the following sources?**
(Please write a number in each row. Write 0 (zero) if no funding comes from that source)

		%
a)	Government (includes departments, local, regional, state and national)	_____
b)	Student fees or school charges paid by parents	_____
c)	Benefactors, donations, bequests, sponsorships, parent fundraising	_____
d)	Other	_____
	Total	100%

School location

Q4 **Which of the following definitions best describes the community in which your school is located?**
(Please tick only one box)

A village, hamlet or rural area (fewer than 3 000 people) ☐1

A small town (3 000 to about 15 000 people) ☐2

A town (15 000 to about 100 000 people) ☐3

A city (100 000 to about 1 000 000 people) ☐4

A large city (with over 1 000 000 people) ☐5

Competition between schools

Q5 **We are interested in the options parents have when choosing a school for their children. Which of the following statements best describes the schooling available to students in your location?**
(Please tick only one box)

There are two or more other schools in this area that compete for our students ☐1

There is one other school in this area that competes for our students ☐2

There are no other schools in this area that compete for our students ☐3

Compositional school characteristics

Total school enrolment per gender

Q6 **As at <month day, 2009>, what was the total school enrolment (number of students)?**
(Please write a number in each line. Write 0 (zero) if there are none)

a) Number of boys: _____

b) Number of girls: _____

Note.

<month day, 2009> - This is a date about one month before the data collection of the Main Survey starts in the country or economy.

% students repeating grade

Q7 **About what percentage of students in your school repeated a grade, at these <ISCED levels>, last academic year?**
(Please write a number in each row. Write 0 (zero) if nobody repeated a grade. Tick the 'not available' box if the <ISCED level> does not exist in your school)

		%	<ISCED level> not available in this school
a)	The approximate percentage of students repeating a grade at <ISCED 2> in this school last year was:	_____	☐ 996
b)	The approximate percentage of students repeating a grade at <ISCED 3> in this school last year was:	_____	☐ 996

Note.

<ISCED level> - This term refers to the International Standard Classification of Education (ISCED-97) which was adopted by the UNESCO General Conference in 1997 (OECD, 1999). The structure of educational systems varies widely between countries, and ISCED-97 provides a multi-dimensional framework to collect and report internationally comparable data on educational programmes with a similar level of educational content. Six ISCED levels are defined:

- ISCED level 0: Pre-primary level of education. Should be centre or school-based, be designed to meet the educational and development needs of children at least 3 years of age and have staff that are adequately trained to provide an educational programme for the children.
- ISCED level 1: Primary level of education. Beginning of systematic studies characteristic of primary education, *e.g.* reading, writing and mathematics. Entry into the nationally designated primary institutions or programmes.
- ISCED level 2: Lower secondary level of education. Programmes at the start of level 2 should correspond to the point where programmes are beginning to be organised in a more subject-oriented pattern, using more specialised teachers conducting classes in their field of specialisation.
- ISCED level 3: Upper secondary level of education. The final stage of secondary education in most OECD countries. Instruction is often more organised along subject-matter lines than at ISCED level 2 and teachers typically need to have a higher level, or more subject-specific, qualification than at ISCED level 2. ISCED 3A is designed to provide direct access to ISCED 5A. ISCED 3B is designed to provide direct access to ISCED 5B. ISCED 3C is not designed to lead directly to ISCED 5A or 5B. These programmes lead directly to labour market, ISCED 4 programmes or other ISCED 3 programmes.
- ISCED level 4: Post-secondary non-tertiary education. They are often not significantly more advanced than programmes at ISCED level 3 but they serve to broaden the knowledge of participants who have already completed a programme at level 3.

- ISCED levels 5/6: Tertiary level of education.
  - ISCED 5A programmes that are largely theoretically based and are intended to provide sufficient qualifications for gaining entry into advanced research programmes and professions with high skills requirements.
  - ISCED 5B programmes that are generally more practical/technical/occupationally specific than ISCED 5A programmes.
  - ISCED level 6 is reserved for tertiary programmes that lead to the award of an advanced research qualification.

REFERENCE

OECD (1999) Classifying Educational Programmes Manual for ISCED-97 Implementation in OECD Countries. Paris: OECD Publications. Available on-line: *http://www.oecd.org/dataoecd/7/2/1962350.pdf.*

% of immigrant students

Q8 **About how many students in <national modal grade for 15-year-olds> in your school have a <first language> that is not <the test language>?**
(Please tick only one box.)

a) 60% or more ☐1
b) 40% or more but less than 60% ☐2
c) 20% or more but less than 40% ☐3
d) 10% or more but less than 20% ☐4
e) More than 0% but less than 10% ☐5
f) None ☐6

Note.

<national modal grade for 15-year-olds> - This is the actual name of the grade attended by most 15-year-olds in the participating country or economy.
<first language> refers to the language first learnt by the student as a child – often referred to as the mother-tongue. In administering the questionnaire, **<the test language>** is replaced with the name of the language of the test.

Composition and qualification of teaching staff

Q9 **How many of the following are on the staff of your school?**
Include both full-time and part-time teachers. *A full-time teacher is employed at least 90% of the time as a teacher for the full school year. All other teachers should be considered part-time.*
(Please write a number in each space provided. Write 0 (zero) if there is none)

		Full-time	Part-time
a)	Teachers in TOTAL	_____	_____
b)	Teachers fully certified by <the appropriate authority>	_____	_____
c)	Teachers with an <ISCED5A> qualification	_____	_____

Note.

<Appropriate authority> – This is the government agency which is empowered to certify that a person is permitted to work as a school teacher.
<ISCED 5A> typically involves three or four years full time tertiary study (such as a Bachelor's Degree, for example). For a detailed definition of ISCED levels, see the annotation to Q7.

The school's resources

Availability of computers

		Number
Q10a	At your school, what is the total number of students in the <national modal grade for 15-year-olds>?	_____
Q10b	Approximately, how many computers are available for these students for educational purposes?	_____
Q10c	Approximately, how many of these computers are connected to the Internet/World Wide Web?	_____

Note.

<national modal grade for 15-year-olds> - *This is the actual name of the grade attended by most 15-year-olds in the participating country or economy.*

School resources (*e.g.* teacher shortage; quality of educational resources)

Q11 **Is your school s capacity to provide instruction hindered by any of the following issues?**

(Please tick one box in each row)

		Not at all	Very little	To some extent	A lot
a)	A lack of qualified science teachers	☐1	☐2	☐3	☐4
b)	A lack of qualified mathematics teachers	☐1	☐2	☐3	☐4
c)	A lack of qualified <test language> teachers	☐1	☐2	☐3	☐4
d)	A lack of qualified teachers of other subjects	☐1	☐2	☐3	☐4
e)	A lack of library staff	☐1	☐2	☐3	☐4
f)	A lack of other support personnel	☐1	☐2	☐3	☐4
g)	Shortage or inadequacy of science laboratory equipment	☐1	☐2	☐3	☐4
h)	Shortage or inadequacy of instructional materials (*e.g.* textbooks)	☐1	☐2	☐3	☐4
i)	Shortage or inadequacy of computers for instruction	☐1	☐2	☐3	☐4
j)	Lack or inadequacy of Internet connectivity	☐1	☐2	☐3	☐4
k)	Shortage or inadequacy of computer software for instruction	☐1	☐2	☐3	☐4
l)	Shortage or inadequacy of library materials	☐1	☐2	☐3	☐4
m)	Shortage or inadequacy of audio-visual resources	☐1	☐2	☐3	☐4

Note.

In administering the questionnaire, the term **<test language>** *is adapted to the name of the language used in the reading literacy test in the participating country or economy.*

School curriculum and assessment

Student grouping by ability

Q12 *Some schools organise instruction differently for students with different abilities*. **What is your school s policy about this for students in <national modal grade for 15-year-olds>?**
(Please tick one box in each row.)

		For all subjects	For some subjects	Not for any subject
a)	Students are grouped by ability into different classes	☐ 1	☐ 2	☐ 3
b)	Students are grouped by ability within their classes	☐ 1	☐ 2	☐ 3

Note.

<national modal grade for 15-year-olds> - This is the actual name of the grade attended by most 15-year-olds in the participating country or economy.

Extra-curricular school activities

Q13 **<This academic year>, which of the following activities does your school offer to students in the <national modal grade for 15-year olds>?**
(Please tick one box in each row)

		Yes	No
a)	Band, orchestra or choir	☐ 1	☐ 2
b)	School play or school musical	☐ 1	☐ 2
c)	School yearbook, newspaper or magazine	☐ 1	☐ 2
d)	Volunteering or service activities, *e.g.* <national example>	☐ 1	☐ 2
e)	Book club	☐ 1	☐ 2
f)	Debating club or debating activities	☐ 1	☐ 2
g)	School club or school competition for foreign language, math or science	☐ 1	☐ 2
h)	Academic club	☐ 1	☐ 2
i)	Art club or art activities	☐ 1	☐ 2
j)	Sporting team or sporting activities	☐ 1	☐ 2
k)	Lectures and/or seminars (*e.g.* guest speakers such as writers or journalists)	☐ 1	☐ 2
l)	Collaboration with local libraries	☐ 1	☐ 2
m)	Collaboration with local newspapers	☐ 1	☐ 2
n)	<Country: specific item>	☐ 1	☐ 2

Note.

<This academic year> – This term refers to the year of schooling which is not necessarily the calendar year.
<national modal grade for 15-year-olds> - This is the actual name of the grade attended by most 15-year-olds in the participating country or economy.

Curricular options offered to immigrant students

Q14 **Does your school offer any of the following options to students in <national modal grade for 15-year olds> whose <first language> is not <the test language>?**
(Please tick only one box in each row)

		Yes	No
a)	These students attend regular classes and receive additional periods of instruction aimed at developing <test language> skills (*e.g.* reading literacy, grammar, vocabulary, communication)	☐1	☐2
b)	Before transferring to regular classes, these students attend a preparatory programme aimed at developing <test language> skills (*e.g.* reading literacy, grammar, vocabulary, communication)	☐1	☐2
c)	Before transferring to regular classes, these students receive some instruction in school subjects through their <first language>	☐1	☐2
d)	These students receive significant amounts of instruction in their <first language> aimed at developing proficiency in both languages	☐1	☐2
e)	Class size is reduced to cater to the special needs of these students	☐1	☐2

Note.

<national modal grade for 15-year-olds> - This is the actual name of the grade attended by most 15-year-olds in the participating country or economy.
<first language> refers to the language first learnt by the student as a child – often referred to as the mother-tongue. In administering the questionnaire, **<the test language>** is replaced with the name of the language of the test.

General assessment practices

Q15 **Generally, in your school, how often are <national modal grade for 15-year-olds> students assessed using the following methods?**
(Please tick only one box in each row)

		Never	1~~2~~ times a year	3~~5~~ times a year	Monthly	More than once a month
a)	Standardised tests	☐1	☐2	☐3	☐4	☐5
b)	Teacher-developed tests	☐1	☐2	☐3	☐4	☐5
c)	Teachers' judgmental ratings	☐1	☐2	☐3	☐4	☐5
d)	Student <portfolios>	☐1	☐2	☐3	☐4	☐5
e)	Student assignments/ projects/homework	☐1	☐2	☐3	☐4	☐5

Note.

<national modal grade for 15-year-olds> - This is the actual name of the grade attended by most 15-year-olds in the participating country or economy.
<first language> refers to the language first learnt by the student as a child – often referred to as the mother-tongue. In administering the questionnaire, **<the test language>** is replaced with the name of the language of the test.

Purposes of assessment

Q16 **In your school, are assessments of students in <national modal grade for 15-year-olds> used for any of the following purposes?**
(Please tick only one box in each row)

		Yes	No
a)	To inform parents about their child's progress	☐ 1	☐ 2
b)	To make decisions about students' retention or promotion	☐ 1	☐ 2
c)	To group students for instructional purposes	☐ 1	☐ 2
d)	To compare the school to <district or national> performance	☐ 1	☐ 2
e)	To monitor the school's progress from year to year	☐ 1	☐ 2
f)	To make judgements about teachers' effectiveness	☐ 1	☐ 2
g)	To identify aspects of instruction or the curriculum that could be improved	☐ 1	☐ 2
h)	To compare the school with other schools	☐ 1	☐ 2

Note.

<national modal grade for 15-year-olds> - *This is the actual name of the grade attended by most 15-year-olds in the participating country or economy.*

School climate

Student-related and teacher-related factors affecting school climate

Q17 **In your school, to what extent is the learning of students hindered by the following phenomenon?**
(Please tick one box in each row.)

		Not at all	Very little	To some extent	A lot
a)	Teachers' low expectations of students	☐ 1	☐ 2	☐ 3	☐ 4
b)	Student absenteeism	☐ 1	☐ 2	☐ 3	☐ 4
c)	Poor student-teacher relations	☐ 1	☐ 2	☐ 3	☐ 4
d)	Disruption of classes by students	☐ 1	☐ 2	☐ 3	☐ 4
e)	Teachers not meeting individual students' needs	☐ 1	☐ 2	☐ 3	☐ 4
f)	Teacher absenteeism	☐ 1	☐ 2	☐ 3	☐ 4
g)	Students skipping classes	☐ 1	☐ 2	☐ 3	☐ 4
h)	Students lacking respect for teachers	☐ 1	☐ 2	☐ 3	☐ 4
i)	Staff resisting change	☐ 1	☐ 2	☐ 3	☐ 4
j)	Student use of alcohol or illegal drugs	☐ 1	☐ 2	☐ 3	☐ 4
k)	Teachers being too strict with students	☐ 1	☐ 2	☐ 3	☐ 4
l)	Students intimidating or bullying other students	☐ 1	☐ 2	☐ 3	☐ 4
m)	Students not being encouraged to achieve their full potential	☐ 1	☐ 2	☐ 3	☐ 4

Parental achievement pressure

Q18 **Which statement below best characterises parental expectations towards your school?**
(Please tick only one box)

- There is *constant pressure* from many parents, who expect our school to set very high academic standards and to have our students achieve them ☐1
- Pressure on the school to achieve higher academic standards among students comes from a *minority of parents* ☐2
- Pressure from parents on the school to achieve higher academic standards among students is *largely absent* ☐3

School policies and practices

Student admission policies

Q19 **How often are the following factors considered when students are admitted to your school?**
(Please tick one box in each row.)

		Never	Sometimes	Always
a)	Residence in a particular area	☐1	☐2	☐3
b)	Student's record of academic performance (including placement tests)	☐1	☐2	☐3
c)	Recommendation of feeder schools	☐1	☐2	☐3
d)	Parents' endorsement of the instructional or religious philosophy of the school	☐1	☐2	☐3
e)	Whether the student requires or is interested in a special programme	☐1	☐2	☐3
f)	Preference given to family members of current or former students	☐1	☐2	☐3
g)	Other	☐1	☐2	☐3

Student transferring policies

Q20 **In your school, how likely is it that a student in <national modal grade for 15-year-olds> would be transferred to another school because of the following reasons?**
(Please tick one box in each row)

If students are never transferred, go to Q21

		Not likely	Likely	Very likely
a)	Low academic achievement	☐1	☐2	☐3
b)	High academic achievement	☐1	☐2	☐3
c)	Behavioural problems	☐1	☐2	☐3
d)	Special learning needs	☐1	☐2	☐3
e)	Parents' or guardians' request	☐1	☐2	☐3
f)	Other	☐1	☐2	☐3

Note.

<national modal grade for 15-year-olds> - This is the actual name of the grade attended by most 15-year-olds in the participating country or economy.

Accountability to parents

Q21 **This set of questions explores aspects of the school s <accountability> to parents.**
(Please tick one box in each row)

		Yes	No
a)	Does your school provide information to parents of students in <national modal grade for 15-year-olds> on their child's academic performance relative to other students in <national modal grade for 15-year-olds> in your school?	☐1	☐2
b)	Does your school provide information to parents of students in <national modal grade for 15-year-olds> on their child's academic performance relative to national or regional <benchmarks>?	☐1	☐2
c)	Does your school provide information to parents on the academic performance of students in <national modal grade for 15-year-olds> as a group relative to students in the same grade in other schools?	☐1	☐2

Note.

<national modal grade for 15-year-olds> - *This is the actual name of the grade attended by most 15-year-olds in the participating country or economy.*

Use of achievement data for accountability

Q22 **In your school, are achievement data used in any of the following <accountability procedures>?**
Achievement data include aggregated school or grade-level test scores or grades, or graduation rates.
(Please tick one box in each row)

		Yes	No
a)	Achievement data are posted publicly (*e.g.* in the media)	☐1	☐2
b)	Achievement data are used in evaluation of the principal's performance	☐1	☐2
c)	Achievement data are used in evaluation of teachers' performance	☐1	☐2
d)	Achievement data are used in decisions about instructional resource allocation to the school	☐1	☐2
e)	Achievement data are tracked over time by an administrative authority	☐1	☐2

Teacher evaluation

Q23 **During the last year, have any of the following methods been used to monitor the practice of <test language> teachers at your school?**
(Please tick one box in each row.)

		Yes	No
a)	Tests or assessments of student achievement	☐1	☐2
b)	Teacher peer review (of lesson plans, assessment instruments, lessons)	☐1	☐2
c)	Principal or senior staff observations of lessons	☐1	☐2
d)	Observation of classes by inspectors or other persons external to the school	☐1	☐2

Note.

In administering the questionnaire, **<the test language>** *is replaced with the name of the language of the test in the participating country or economy.*

School autonomy: responsibility for staffing, budgeting, curriculum and assessment

Q24 **Regarding your school, who has a considerable responsibility for the following tasks?**
(Please tick as many boxes as appropriate in each row)

		Principals	Teachers	<School governing board>	<Regional or local education authority>	National education authority
a)	Selecting teachers for hire	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b)	Firing teachers	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c)	Establishing teachers' starting salaries	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d)	Determining teachers' salaries increases	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
e)	Formulating the school budget	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
f)	Deciding on budget allocations within the school	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
g)	Establishing student disciplinary policies	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
h)	Establishing student assessment policies	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
i)	Approving students for admission to the school	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
j)	Choosing which textbooks are used	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
k)	Determining course content	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
l)	Deciding which courses are offered	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

School autonomy: external influences on staffing, budgeting, curriculum and assessment

Q25 **Regarding your school, which of the following bodies exert a direct influence on decision-making about staffing, budgeting, instructional content and assessment practices?**
(Please tick as many boxes as apply)

		Area of influence			
		Staffing	Budgeting	Instructional content	Assessment practices
a)	Regional or national education authorities (*e.g.* inspectorates)	☐ 1	☐ 2	☐ 3	☐ 4
b)	The school's <governing board>	☐ 1	☐ 2	☐ 3	☐ 4
c)	Parent groups	☐ 1	☐ 2	☐ 3	☐ 4
d)	Teacher groups (*e.g.* Staff Association, curriculum committees, trade union)	☐ 1	☐ 2	☐ 3	☐ 4
e)	Student groups (*e.g.* Student Association, youth organisation)	☐ 1	☐ 2	☐ 3	☐ 4
f)	External examination boards	☐ 1	☐ 2	☐ 3	☐ 4

Educational leadership

Q26 **Below you can find statements about your management of this school. Please indicate the frequency of the following activities and behaviours in your school *during the last school year*.**

(Please tick only one box in each row)

	Never	Seldom	Quite often	Very often
I make sure that the professional development activities of teachers are in accordance with the teaching goals of the school	☐ 1	☐ 2	☐ 3	☐ 4
I ensure that teachers work according to the school's educational goals	☐ 1	☐ 2	☐ 3	☐ 4
I observe instruction in classrooms	☐ 1	☐ 2	☐ 3	☐ 4
I use student performance results to develop the school's educational goals	☐ 1	☐ 2	☐ 3	☐ 4
I give teachers suggestions as to how they can improve their teaching	☐ 1	☐ 2	☐ 3	☐ 4
I monitor students' work	☐ 1	☐ 2	☐ 3	☐ 4
When a teacher has problems in his/her classroom, I take the initiative to discuss matters	☐ 1	☐ 2	☐ 3	☐ 4
I inform teachers about possibilities for updating their knowledge and skills	☐ 1	☐ 2	☐ 3	☐ 4
I check to see whether classroom activities are in keeping with our educational goals	☐ 1	☐ 2	☐ 3	☐ 4
I take exam results into account in decisions regarding curriculum development	☐ 1	☐ 2	☐ 3	☐ 4
I ensure that there is clarity concerning the responsibility for coordinating the curriculum	☐ 1	☐ 2	☐ 3	☐ 4
I pay attention to disruptive behaviour in classrooms	☐ 1	☐ 2	☐ 3	☐ 4
I take over lessons from teachers who are unexpectedly absent	☐ 1	☐ 2	☐ 3	☐ 4

About you

Q27 **Are you female or male?**

Female	Male
☐ 1	☐ 2

STUDENT QUESTIONNAIRE

The student questionnaire is administered after the literacy assessment and takes students about 30 minutes to complete. The core questions on home background are similar to those used in the previous PISA assessments. The questionnaire covers the following aspects:

- student characteristics and educational career
- family context and home resources
- individual engagement in reading
- instructional time, learning and assessment
- classroom and school climate
- access to and use of libraries
- student's strategies in reading and understanding texts

The questions on the strategies in reading and understanding texts are not replicated in this annex. A sample item for this scale is given in Chapter 1, metacognition.

Technical terms are given in <brackets> and are adapted to the national context by the national data collection centre of the participating country or economy. In this annex, an explanation of the technical terms is given below the questionnaire item.

Student basic characteristics

Grade

Q1 **What <grade> are you in?**

_____
<grade>

Note.

<Grade> - This term refers to the administrative level of the student in the school. In many countries, the number of years in schooling is the usual measure of grade.

Study programme

Q2 **Which one of the following <programmes> are you in?**

(Please tick only one box)

<Programme 1> ☐1
<Programme 2> ☐2
<Programme 3> ☐3
<Programme 4> ☐4
<Programme 5> ☐5
<Programme 6> ☐6

Date of birth

Q3 **On what date were you born?**

(Please write the day, month and year you were born)

_____ **Day** _____ **Month** 19___ **Year**

Gender

Q4 Are you female or male?

Female	Male
☐1	☐2

Student's educational career

ISCED 0 attendance

Q5 Did you attend <ISCED 0>?

No ☐1
Yes, for one year or less ☐2
Yes, for more than one year ☐3

Note.

<ISCED 0> - This level refers to pre-primary education defined as the initial stage of organised instruction designed primarily to introduce very young children to a school-type environment. Instruction is school-based or centre-based, typically for children between 3 and 6 years. For a detailed definition of ISCED levels, see the annotation to Q7 of the school questionnaire.

ISCED 1 starting age

Q6 How old were you when you started <ISCED 1>?

_____ Years

Note.

<ISCED 1> - This refers to primary education which begins between age 5 and 7 and generally lasts 4 years (*e.g.* Germany) to 6 years (mode of OECD countries). Primary education is designed to provide a sound basic education in reading, writing and mathematics along with an elementary understanding of other subjects. For a detailed definition of ISCED levels, see the annotation to Q7 of the school questionnaire.

Grade repeating

Q7 Have you ever repeated a <grade>?

(Please <tick> only one box in each row.)

		No, never	Yes, once	Yes, twice or more
a)	At <ISCED 1>	☐1	☐2	☐3
b)	At <ISCED 2>	☐1	☐2	☐3
c)	At <ISCED 3>	☐1	☐2	☐3

Note.

<Grade> - This term refers to the administrative level of the student in the school. In many countries, the number of years in schooling is the usual measure of grade.
For a definition of the **<ISCED level>**, see the annotation to Q7 of the school questionnaire.

Family context and home resources

Family structure

Q8 **Who usually lives at <home> with you?**
(Please <tick> one box in each row.)

		Yes	No
a)	Mother (including stepmother or foster mother)	☐ 1	☐ 2
b)	Father (including stepfather or foster father)	☐ 1	☐ 2
c)	Brother(s) (including stepbrothers)	☐ 1	☐ 2
d)	Sister(s) (including stepsisters)	☐ 1	☐ 2
e)	Others (*e.g.* cousin)	☐ 1	☐ 2

Mother's main job 1

Q9a **What is your mother s main job?**
(*e.g.* school teacher, kitchen-hand, sales manager)
(If she is not working now, please tell us her last main job)

Please write in the job title. _____

Mother's main job 2

Q9b **What does your mother do in her main job?**
(*e.g.* teaches high school students, helps the cook prepare meals in a restaurant, manages a sales team)
Please use a sentence to describe the kind of work she does or did in that job.

_____

Mother's education

Q10 **What is the <highest level of schooling> completed by your mother?**
If you are not sure which box to choose, please ask the <test administrator> for help.
(Please tick only one box)

<ISCED level 3A> ☐ 1
<ISCED level 3B, 3C> ☐ 2
<ISCED level 2> ☐ 3
<ISCED level 1> ☐ 4
She did not complete <ISCED level 1> ☐ 5

Mother's qualifications

Q11 **Does your mother have any of the following qualifications?**
If you are not sure how to answer this question, please ask the <test administrator> for help.
(Please tick one box in each row)

		Yes	No
a)	<ISCED level 6>	☐ 1	☐ 2
b)	<ISCED level 5A>	☐ 1	☐ 2
c)	<ISCED level 5B>	☐ 1	☐ 2
d)	<ISCED level 4>	☐ 1	☐ 2

Note.
For a definition of **<ISCED level>**, see the annotation to Q7 of the school questionnaire.

Employment status mother

Q12 **What is your mother currently doing?**
(Please <tick> only one box.)

a) Working full-time <for pay> ☐1
b) Working part-time <for pay> ☐2
c) Not working, but looking for a job ☐3
d) Other (*e.g.* home duties, retired) ☐4

Father's main job 1

Q13a **What is your father s main job?**
(*e.g.* school teacher, kitchen-hand, sales manager)
(If he is not working now, please tell us his last main job)

Please write in the job title. _____

Father's main job 2

Q13b **What does your father do in his main job?**
(*e.g.* teaches high school students, helps the cook prepare meals in a restaurant, manages a sales team)
Please use a sentence to describe the kind of work he does or did in that job.

_____

Father's education

Q14 **What is the <highest level of schooling> completed by your father?**
If you are not sure how to answer this question, please ask the <test administrator> for help.
(Please tick only one box)

<ISCED level 3A> ☐1
<ISCED level 3B, 3C> ☐2
<ISCED level 2> ☐3
<ISCED level 1> ☐4
He did not complete <ISCED level 1> ☐5

Father's qualifications

Q15 **Does your father have any of the following qualifications?**
If you are not sure which box to choose, please ask the <test administrator> for help.
(Please tick one box in each row)

		Yes	No
a)	<ISCED level 6>	☐1	☐2
b)	<ISCED level 5A>	☐1	☐2
c)	<ISCED level 5B>	☐1	☐2
d)	<ISCED level 4>	☐1	☐2

Note.
For a definition of <ISCED level>, see the annotation to Q7 of the school questionnaire.

Employment status father

Q16 **What is your father currently doing?**

(Please tick only one box.)

a) Working full-time <for pay> ☐1

b) Working part-time <for pay> ☐2

c) Not working, but looking for a job ☐3

d) Other (*e.g.* home duties, retired) ☐4

Country of birth

Q17 **In what country were you and your parents born?**

(Please tick one answer in each column)

	You	Mother	Father
<Country A>	☐01	☐01	☐01
<Country B>	☐02	☐02	☐02
<Country C>	☐03	☐03	☐03
<Country D>	☐04	☐04	☐04
<…etc.>	☐<XX>	☐<XX>	☐<XX>
Other country	☐<XX>	☐<XX>	☐<XX>

Age at time of arrival

Q18 **If you were NOT born in <country of test>, how old were you when you arrived in <country of test>?**

If you were less than 12 months old, please write zero (0)

If you were born in <country of test> please skip this question and go to Q19

_____*Years*

Home language

Q19 **What language do you speak at home most of the time?**

(Please tick only one box)

<Language 1> ☐ <xxx>
<Language 2> ☐ <xxx>
<Language 3> ☐ <xxx>
< …etc. > ☐ <xxx>
Other language ☐ <xxx>

Home resources

Q20 **Which of the following are in your home?**

(Please tick one box in each row)

		Yes	No
a)	A desk to study at	☐ 1	☐ 2
b)	A room of your own	☐ 1	☐ 2
c)	A quiet place to study	☐ 1	☐ 2
d)	A computer you can use for school work	☐ 1	☐ 2
e)	Educational software	☐ 1	☐ 2
f)	A link to the Internet	☐ 1	☐ 2
g)	Classic literature (*e.g.*. < classical author in the country's language >)	☐ 1	☐ 2
h)	Books of poetry	☐ 1	☐ 2
i)	Works of art (*e.g.* paintings)	☐ 1	☐ 2
j)	Books to help with your school work	☐ 1	☐ 2
k)	<Technical reference books>	☐ 1	☐ 2
l)	A dictionary	☐ 1	☐ 2
m)	A dishwasher	☐ 1	☐ 2
n)	A <DVD> player	☐ 1	☐ 2
o)	<Country-specific wealth item 1>	☐ 1	☐ 2
p)	<Country-specific wealth item 2>	☐ 1	☐ 2
q)	<Country-specific wealth item 3>	☐ 1	☐ 2

Family wealth

Q21 **How many of these are there at your home?**

(Please tick only one box in each row)

		None	One	Two	Three or more
a)	Cellular phones	☐ 1	☐ 2	☐ 3	☐ 4
b)	Televisions	☐ 1	☐ 2	☐ 3	☐ 4
c)	Computers	☐ 1	☐ 2	☐ 3	☐ 4
d)	Cars	☐ 1	☐ 2	☐ 3	☐ 4
e)	Rooms with a bath or shower	☐ 1	☐ 2	☐ 3	☐ 4

Books in the home

Q22 **How many books are there in your home?**

There are usually about 40 books per metre of shelving. Do not include magazines, newspapers, or your schoolbooks.

(Please tick only one box)

- 0-10 books ☐1
- 11-25 books ☐2
- 26-100 books ☐3
- 101-200 books ☐4
- 201-500 books ☐5
- More than 500 books ☐6

Individual engagement in reading

Reading for enjoyment

Q23 **About how much time do you usually spend reading for enjoyment?**

(Please tick only one box)

- I do not read for enjoyment ☐1
- 30 minutes or less a day ☐2
- More than 30 minutes to less than 60 minutes each day ☐3
- 1 to 2 hours a day ☐4
- More than 2 hours a day ☐5

Reading attitude

Q24 **How much do you disagree or agree with these statements about reading?**

(Please tick only one box in each row)

		Strongly disagree	Disagree	Agree	Strongly agree
a)	I read only if I have to	☐1	☐2	☐3	☐4
b)	Reading is one of my favourite hobbies	☐1	☐2	☐3	☐4
c)	I like talking about books with other people	☐1	☐2	☐3	☐4
d)	I find it hard to finish books	☐1	☐2	☐3	☐4
e)	I feel happy if I receive a book as a present	☐1	☐2	☐3	☐4
f)	For me, reading is a waste of time	☐1	☐2	☐3	☐4
g)	I enjoy going to a bookstore or a library	☐1	☐2	☐3	☐4
h)	I read only to get information that I need	☐1	☐2	☐3	☐4
i)	I cannot sit still and read for more than a few minutes	☐1	☐2	☐3	☐4
j)	I like to express my opinions about books I have read	☐1	☐2	☐3	☐4
k)	I like to exchange books with my friends	☐1	☐2	☐3	☐4

Reading diversity

Q25 **How often do you read these materials because you want to?**
(Please tick only one box on each row)

		Never or almost never	A few times a year	About once a month	Several times a month	Several times a week
a)	Magazines	☐1	☐2	☐3	☐4	☐5
b)	Comic books	☐1	☐2	☐3	☐4	☐5
c)	Fiction (novels, narratives, stories)	☐1	☐2	☐3	☐4	☐5
d)	Non-fiction books	☐1	☐2	☐3	☐4	☐5
e)	Newspapers	☐1	☐2	☐3	☐4	☐5

Engagement in reading electronic text types

Q26 **How often are you involved in the following reading activities?**
(Please tick only one box on each row. If you don't know what the activity is tick "I don't know what it is")

		I don t know what it is	Never or almost never	Several times a month	Several times a week	Several times a day
a)	Reading emails	☐1	☐2	☐3	☐4	☐5
b)	<Chat on line> (*e.g.* <MSN>)	☐1	☐2	☐3	☐4	☐5
c)	Reading online news	☐1	☐2	☐3	☐4	☐5
d)	Using an online dictionary or encyclopaedia (*e.g.* Wikipedia)	☐1	☐2	☐3	☐4	☐5
e)	Searching online information to learn about a particular topic	☐1	☐2	☐3	☐4	☐5
f)	Taking part in online group discussions or forums	☐1	☐2	☐3	☐4	☐5
g)	Searching for practical information online (*e.g.* schedules, events, tips, recipes)	☐1	☐2	☐3	☐4	☐5

Learning by reading strategies

Learning by reading strategies (elaboration, memorisation and control)

Q27 **When you are studying, how often do you do the following?**
(Please tick only one box in each row)

		Almost never	Sometimes	Often	Almost always
a)	When I study, I try to memorize everything that is covered in the text.	☐1	☐2	☐3	☐4
b)	When I study, I start by figuring out what exactly I need to learn.	☐1	☐2	☐3	☐4
c)	When I study, I try to memorize as many details as possible.	☐1	☐2	☐3	☐4
d)	When I study, I try to relate new information to prior knowledge acquired in other subjects.	☐1	☐2	☐3	☐4
e)	When I study, I read the text so many times that I can recite it.	☐1	☐2	☐3	☐4
f)	When I study, I check if I understand what I have read.	☐1	☐2	☐3	☐4
g)	When I study, I read the text over and over again.	☐1	☐2	☐3	☐4
h)	When I study, I figure out how the information might be useful outside school.	☐1	☐2	☐3	☐4
i)	When I study, I try to figure out which concepts I still haven't really understood.	☐1	☐2	☐3	☐4
j)	When I study, I try to understand the material better by relating it to my own experiences.	☐1	☐2	☐3	☐4
k)	When I study, I make sure that I remember the most important points in the text.	☐1	☐2	☐3	☐4
l)	When I study, I figure out how the text information fits in with what happens in real life.	☐1	☐2	☐3	☐4
l)	When I study and I don't understand something, I look for additional information to clarify this.	☐1	☐2	☐3	☐4

Instructional time, learning and assessment

Length of class period

Q28 **How many minutes, on average, are there in a <class period> for the following subjects?**

Number of minutes in a <class period> in <test language> _____ Minutes
Number of minutes in a <class period> in <mathematics> _____ Minutes
Number of minutes in a <class period> in <science> _____ Minutes

Note.

<class period> - This term refers to the length of time each lesson runs for in a normal school week.
<test language> - This refers to the language of instruction in which the PISA reading assessment is administered. In some countries <test language> may be taught in different school subjects, *e.g.* English language and English literature. If this is the case, <test language> has been adapted accordingly.
<mathematics> - This consists of all mathematics subjects and courses.
<science> - This term refers only to the core science subjects of physics, chemistry, Earth science and biology either taught in the country's curriculum as separate science subjects, or taught within a single "integrated-science" subject. The term does not include related subjects such as engineering, technology, mathematics, psychology, economics, nor possible Earth science topics included in geography courses. In many countries this term has been adapted to the national context.

Number of class periods

Q29 **How many <class periods> per week do you typically have for the following subjects**

Number of class periods per week in <test language> _____ <class periods>

Number of class periods per week in <mathematics> _____ <class periods>

Number of class periods per week in <science> _____ <class periods>

Note.

See annotations to Q28 of the student questionnaire.

Total number of class periods

Q30 **In a normal, full week at school, how many <class periods> do you have <in total>?**

Number of **ALL** <class periods> _____ <class periods>

Note.

See annotations to Q28 of the student questionnaire.

Attendance out-of-school-time lessons

Q31 **What type of out-of-school-time lessons do you attend currently?**

These are only lessons in subjects that you are also learning at school, that you spend learning extra time outside of normal school hours. The lessons may be given at your school, at your home or somewhere else.

(Please tick only one box in each row)

		Yes	No
a)	<Enrichment lessons> in <test language>	☐1	☐2
b)	<Enrichment lessons> in <mathematics>	☐1	☐2
c)	<Enrichment lessons> in <science>	☐1	☐2
d)	<Enrichment lessons> in other school subjects	☐1	☐2
e)	<Remedial lessons> in <test language>	☐1	☐2
f)	<Remedial lessons> in <mathematics>	☐1	☐2
g)	<Remedial lessons> in <science>	☐1	☐2
h)	<Remedial lessons> in other subjects	☐1	☐2
i)	Lessons to improve your <study skills>	☐1	☐2

Note.

<Out-of-school-time lessons> - *This term refers to any lessons in the student's school subjects, that he or she spends extra time learning outside of normal school hours. The lessons might be held at school, at home, or elsewhere.*

<Remedial lessons > - This refers to any lessons in addition to regular lessons designed to help students with learning difficulties.

<Enrichment lessons> - This refers to any lessons in addition to regular lessons designed to extend abilities of more able students.

<Study skills> - Study skills are strategies and methods of purposeful learning, usually centred around reading and writing, time management, doing homework and/or preparing for tests or exams.

For the definition of **<test language>**, **<mathematics>**, and **<science>** see the annotations to Q28 in the student questionnaire.

Time spent on out-of-school-time lessons

Q32 **How many hours do you typically spend per week attending out-of-school-time lessons in the following subjects?**

These are only lessons in subjects that you are also learning at school, that you spend learning extra time outside of normal school hours. The lessons may be given at your school, at your home or somewhere else.

(Please tick one box in each column)

	<test language>	<mathematics>	<science>	Other subjects
I do not attend out-of-school time lessons in these subject	☐ 1	☐ 1	☐ 1	☐ 1
Less than 2 hours a week	☐ 2	☐ 2	☐ 2	☐ 2
2 or more but less than 4 hours a week	☐ 3	☐ 3	☐ 3	☐ 3
4 or more but less than 6 hours a week	☐ 4	☐ 4	☐ 4	☐ 4
6 or more hours a week	☐ 5	☐ 5	☐ 5	☐ 5

Note.

<Out-of-school-time lessons> are any lessons in the student's school subjects, that he or she spends extra time learning outside of normal school hours. The lessons might be held at school, at home, or elsewhere. For the definition of **<test language>**, **<mathematics>**, and **<science>** see the annotations to Q28 in the student questionnaire.

Classroom and school climate

Attitude towards school

Q33 **Thinking about what you have learned in school: to what extent do you agree or disagree with the following statements?**

(Please tick only one box in each row)

		Strongly disagree	Disagree	Agree	Strongly agree
a)	School has done little to prepare me for adult life when I leave school	☐ 1	☐ 2	☐ 3	☐ 4
b)	School has been a waste of time	☐ 1	☐ 2	☐ 3	☐ 4
c)	School has helped give me confidence to make decisions	☐ 1	☐ 2	☐ 3	☐ 4
e)	School has taught me things which could be useful in a job	☐ 1	☐ 2	☐ 3	☐ 4

Teacher's interest in student performance

Q34 **How much do you disagree or agree with each of the following statements about teachers at your school?**

(Please tick only one box in each row)

		Strongly disagree	Disagree	Agree	Strongly agree
a)	I get along well with most of my teachers	☐ 1	☐ 2	☐ 3	☐ 4
b)	Most of my teachers are interested in my well-being	☐ 1	☐ 2	☐ 3	☐ 4
c)	Most of my teachers really listen to what I have to say	☐ 1	☐ 2	☐ 3	☐ 4
e)	If I need extra help, I will receive it from my teachers	☐ 1	☐ 2	☐ 3	☐ 4
f)	Most of my teachers treat me fairly	☐ 1	☐ 2	☐ 3	☐ 4

Class size

Q35 **On average, about how many students attend your <test language> class?**

_____ students

Note.

For the definition of **<test language>** see the annotation to Q28 in the student questionnaire.

Classroom climate

Q36 **How often do these things happen in your <test language> lessons?**

(Please tick only one box in each row)

		Never or hardly ever	In some lessons	In most lessons	In all lessons
a)	Students don't listen to what the teacher says	☐ 1	☐ 2	☐ 3	☐ 4
b)	There is noise and disorder	☐ 1	☐ 2	☐ 3	☐ 4
c)	The teacher has to wait a long time for the students to <quieten down>	☐ 1	☐ 2	☐ 3	☐ 4
d)	Students cannot work well	☐ 1	☐ 2	☐ 3	☐ 4
e)	Students don't start working for a long time after the lesson begins	☐ 1	☐ 2	☐ 3	☐ 4

Note.

For the definition of **<test language>** see the annotation to Q28 in the student questionnaire.

Teacher's reading literacy teaching strategies

Q37 **In your <test language> lessons, how often does the following occur?**
(Please tick only one box in each row)

		Never or hardly ever	In some lessons	In most lessons	In all lessons
a)	The teacher asks students to explain the meaning of a text	☐1	☐2	☐3	☐4
b)	The teacher asks questions that challenge students to get a better understanding of a text	☐1	☐2	☐3	☐4
c)	The teacher gives students enough time to think about their answers	☐1	☐2	☐3	☐4
d)	The teacher recommends a book or author to read	☐1	☐2	☐3	☐4
e)	The teacher encourages students to express their opinion about a text	☐1	☐2	☐3	☐4
f)	The teacher helps students relate the stories they read to their lives	☐1	☐2	☐3	☐4
g)	The teacher shows students how the information in texts builds on what they already know	☐1	☐2	☐3	☐4

Note.
For the definition of **<test language>** see the annotation to Q28 in the student questionnaire.

Teacher's instructional strategies in relation to assignments

Q38 **In your <test language> lessons, how often does the following occur?**
(Please tick only one box in each row)

		Never or hardly never	In some lessons	In most lessons	In all lessons
a)	The teacher explains beforehand what is expected of the students	☐1	☐2	☐3	☐4
b)	The teacher checks that students are concentrating while working on the <reading assignment>	☐1	☐2	☐3	☐4
c)	The teacher discusses students' work, after they have finished the <reading assignment>	☐1	☐2	☐3	☐4
d)	The teacher tells students in advance how their work is going to be judged	☐1	☐2	☐3	☐4
e)	The teacher asks whether every student has understood how to complete the <reading assignment>	☐1	☐2	☐3	☐4
f)	The teacher marks students' work	☐1	☐2	☐3	☐4
g)	The teacher gives students the chance to ask questions about the <reading assignment>	☐1	☐2	☐3	☐4
h)	The teacher poses questions that motivate students to participate actively	☐1	☐2	☐3	☐4
i)	The teacher tells students how well they did on the <reading assignment> immediately after	☐1	☐2	☐3	☐4

Note.
For the definition of **<test language>**, see the annotation to Q28 in the student questionnaire.

Libraries

Access to and use of a library

Q39 **How often do you visit a library for the following activities?**
(Please tick only one box in each row)

		Never	A few times a year	About once a month	Several times a month	Several times a week
a)	Borrow books to read for pleasure	☐1	☐2	☐3	☐4	☐5
b)	Borrow books for school work	☐1	☐2	☐3	☐4	☐5
c)	Work on homework, course assignments or research papers	☐1	☐2	☐3	☐4	☐5
d)	Read magazines or newspapers	☐1	☐2	☐3	☐4	☐5
e)	Read books for fun	☐1	☐2	☐3	☐4	☐5
f)	Learn about things that are not course-related, such as sports, hobbies, people or music	☐1	☐2	☐3	☐4	☐5
g)	Use the Internet	☐1	☐2	☐3	☐4	☐5

Availability of a school library

Q40 **Does your school have a <school library>?**

No	Yes
☐1	☐2

INTERNATIONAL OPTIONS

As in previous surveys, additional questionnaire materials were developed and offered as international options to the participating countries and economies. In PISA 2009, these are the Educational Career Questionnaire and the ICT familiarity questionnaire for students, as well as the parent questionnaire.

Educational Career Questionnaire

The Educational Career Questionnaire consists of six questions on the student's interruptions of schooling or change of schools, educational aspirations and grade marks, as well as lessons taken out of school.

The questions refer to ISCED levels, which are explained in the annotation to Q7 of the school questionnaire.

Interruptions during <ISCED 1>

Q1 **Did you ever miss two or more consecutive months of <ISCED 1>?**
(Please tick only one box)

- No, never ☐1
- Yes, once ☐2
- Yes, twice or more ☐3

Interruptions during <ISCED 2>

Q2 **Did you ever miss two or more consecutive months of <ISCED 2>**
(Please tick only one box)

- No, never ☐1
- Yes, once ☐2
- Yes, twice or more ☐3

Change schools during <ISCED 1>

Q3 **Did you change schools when you were attending <ISCED 1>?**
(Please tick only one box)

- No, I attended all of <ISCED 1> at the same school ☐1
- Yes, I changed schools once ☐2
- Yes, I changed schools twice or more ☐3

Change schools during <ISCED 2>

Q4 **Did you change schools when you were attending <ISCED 2>?**
(Please tick only one box)

- No, I attended all of <ISCED 2> at the same school ☐1
- Yes, I changed schools once ☐2
- Yes, I changed schools twice or more ☐3

Educational aspirations

Q5 **Which of the following do you *expect* to complete?**
(Please tick as many as apply)

a) <ISCED level 2> ☐1
b) <ISCED level 3B or C> ☐2
c) <ISCED level 3A> ☐3
d) <ISCED level 4> ☐4
e) <ISCED level 5B> ☐5
f) <ISCED level 5A or 6> ☐6

Out-of-school-time lessons during <ISCED 1>

Q6 **Have you attended the following out-of-school-time lessons during <ISCED 1>?**
These are lessons in subjects that you learned at school during <ISCED 1>, on which you spend extra time learning outside of normal school hours. The lessons might have been held at your <ISCED 1> school, at your home or somewhere else.
(Please tick only one box in each row)

		Yes	No
a)	<Enrichment lessons> in <test language>	☐1	☐2
b)	<Remedial lessons> in <test language>	☐1	☐2
c)	<Private tutoring> on a <one-to-one> basis in <test language> and/or other subjects	☐1	☐2

Note.
For the definition of **<out-of-school-time lessons>**, **<enrichment lessons>**, and **<remedial lessons>** see the annotations to question Q31 in the student questionnaire.
For the definition of **<test language>**, see the annotation to question Q28 in the student questionnaire.

Mark for test language

Q7 **In your last school report, what was your mark in <test language>?**

_____

Note.
For the definition of **<test language>**, see the annotation to question Q28 in the student questionnaire.

ICT FAMILIARITY QUESTIONNAIRE

The Information Communication Technology (ICT) familiarity questionnaire consists of questions regarding the availability of ICT, and the student's use of, and attitudes towards, computers. It is administered to students after the international student questionnaire and takes about five minutes to complete.

Availability of ICT

Availability of ICT at home

Q1 **Is there any of these devices available for you to use *at home*?**
(Please tick one box in each row)

		Yes	Yes, but I don t use it	No
a)	Desktop computer	☐ 1	☐ 2	☐ 3
b)	Portable laptop or notebook	☐ 1	☐ 2	☐ 3
c)	Internet connection	☐ 1	☐ 2	☐ 3
d)	<Video games console>, *e.g.* (Sony PlayStation)	☐ 1	☐ 2	☐ 3
e)	Cell phone	☐ 1	☐ 2	☐ 3
f)	Mp3/Mp4 reader, iPod or similar	☐ 1	☐ 2	☐ 3
g)	Printer	☐ 1	☐ 2	☐ 3
h)	USB (memory) stick	☐ 1	☐ 2	☐ 3

Availability of ICT at school

Q2 **Is there any of these devices available for you to use *at school*?**
(Please tick one box in each row)

		Yes	Yes, but I don t use it	No
a)	Desktop computer	☐ 1	☐ 2	☐ 3
b)	Portable laptop or notebook	☐ 1	☐ 2	☐ 3
c)	Internet connection	☐ 1	☐ 2	☐ 3
d)	Printer	☐ 1	☐ 2	☐ 3
e)	USB (memory) stick	☐ 1	☐ 2	☐ 3

General use of computers

Filter question

Q3 **Have you ever used a computer?**

Yes	No
☐ 1	☐ 2

If you answered Yes to the above question, please continue.

If you answered No, please stop here.

Use of ICT at home

Use of the computer at home

Q4 **How often do you use a computer for following activities *at home*?**
(Please tick one box in each row)

		Never or hardly ever	Once or twice a month	Once or twice a week	Every day or almost every day
a)	Play one-player games	☐1	☐2	☐3	☐4
b)	Play collaborative online games	☐1	☐2	☐3	☐4
c)	Doing homework on the computer	☐1	☐2	☐3	☐4
d)	Use e-mail	☐1	☐2	☐3	☐4
e)	<Chat online> (*e.g.* <MSN®>)	☐1	☐2	☐3	☐4
f)	Browse the Internet for fun (such as watching videos, *e.g.* < YouTube™ >)	☐1	☐2	☐3	☐4
g)	Download music, films, games or software from the Internet	☐1	☐2	☐3	☐4
h)	Publish and maintain a personal website, weblog or blog	☐1	☐2	☐3	☐4
i)	Participate in online forums, virtual communities or spaces (*e.g.* < Second Life® or MySpace™ >)	☐1	☐2	☐3	☐4

Home use of internet and e-mail for school-related tasks

Q5 **How often do you do the following *at home*?**
(Please tick one box in each row)

		Never or hardly ever	Once or twice a month	Once or twice a week	Every day or almost every day
a)	Browse the Internet for schoolwork (*e.g.* preparing an essay or presentation)	☐1	☐2	☐3	☐4
b)	Use e-mail for communication with other pupils about schoolwork	☐1	☐2	☐3	☐4
c)	Use e-mail for communication with teachers and submissions of homework or other schoolwork	☐1	☐2	☐3	☐4
d)	Download, upload or browse material from your school's website (*e.g.* time table or course materials)	☐1	☐2	☐3	☐4
e)	Check the school's website for announcements, *e.g.* absence of teachers	☐1	☐2	☐3	☐4

Use of ICT at school

Use of ICT at school

Q6 **How often do you use a computer for following activities *at school*?**
(Please tick one box in each row)

		Never or hardly ever	Once or twice a month	Once or twice a week	Every day or almost every day
a)	<Chat on line> at school	☐ 1	☐ 2	☐ 3	☐ 4
b)	Use e-mail at school	☐ 1	☐ 2	☐ 3	☐ 4
c)	Browse the Internet for schoolwork	☐ 1	☐ 2	☐ 3	☐ 4
d)	Download, upload or browse material from the school's website (*e.g.* <intranet>)	☐ 1	☐ 2	☐ 3	☐ 4
e)	Post your work on the school's website	☐ 1	☐ 2	☐ 3	☐ 4
f)	Play simulations at school	☐ 1	☐ 2	☐ 3	☐ 4
g)	Practice and drilling, such as for foreign language learning or mathematics	☐ 1	☐ 2	☐ 3	☐ 4
h)	Doing individual homework on a school computer	☐ 1	☐ 2	☐ 3	☐ 4
i)	Use school computers for group work and communication with other students	☐ 1	☐ 2	☐ 3	☐ 4

Use of computers at school in classroom lessons

Q7 **In a typical school week, how much time do you spend using the computer during classroom lessons?**
(Please tick one box in each row)

		No time	0 –30 minutes a week	31-60 minutes a week	More than 60 minutes a week
a)	Computer use in <test language> lessons	☐ 1	☐ 2	☐ 3	☐ 4
b)	Computer use in <mathematics> lessons	☐ 1	☐ 2	☐ 3	☐ 4
c)	Computer use in <science> lessons	☐ 1	☐ 2	☐ 3	☐ 4
d)	Computer use in foreign language lessons	☐ 1	☐ 2	☐ 3	☐ 4

Note.

For the definition of **<test language>**, **<mathematics>** and **<science>** see the annotation to question Q28 in the student questionnaire.

Q8 **To what extent are you able to do each of these tasks on a computer?**
(Please tick one box in each row)

		I can do this very well by myself	I can do this with help from someone	I know what this means but I cannot do it	I don t know what It means
a)	Edit digital photographs or other graphic images	☐1	☐2	☐3	☐4
b)	Create a database (*e.g.* using <Microsoft Access®>)	☐1	☐2	☐3	☐4
c)	Use a spreadsheet to plot a graph	☐1	☐2	☐3	☐4
d)	Create a presentation (*e.g.* using <Microsoft PowerPoint®>)	☐1	☐2	☐3	☐4
e)	Create a multi-media presentation (with sound, pictures, video)	☐1	☐2	☐3	☐4

Use of computers at school outside classroom lessons

Q9 **In a typical school week, how much time do you spend using the computer at school outside classroom lessons,** *e.g.* **in a <school library> or computer room?**
(Please tick only one box)

I never use the computer at school outside classroom lessons ☐1
About half an hour a week ☐2
About an hour a week ☐3
About two hours a week ☐4
About three hours a week ☐5
About four or more hours a week ☐6

Attitude toward computers

Attitude toward computers

Q10 *Thinking about your experience with computers:* **To what extent do you agree with the following statements?**
(Please tick one box in each row)

		Strongly disagree	Disagree	Agree	Strongly agree
a)	It is very important to me to work with a computer	☐1	☐2	☐3	☐4
b)	I think playing or working with a computer is really fun	☐1	☐2	☐3	☐4
c)	I use a computer because I am very interested	☐1	☐2	☐3	☐4
d)	I lose track of time when I am working with the computer	☐1	☐2	☐3	☐4

PARENT QUESTIONNAIRE

One questionnaire is administered per student. The parent questionnaire takes about 20 minutes to complete. The parent questionnaire covers parental reports related to several aspects:

- basic parent characteristics
- child's past reading engagement
- parents' own reading engagement
- home reading resources and support
- parents' background
- parents' perception of and involvement in school
- school choice

Basic parent characteristics

Respondent

Q1 **Who will complete this questionnaire?**
(Please tick all that apply)

a) Mother or other female guardian ☐1
b) Father or other male guardian ☐2
c) Other ☐3

(If other, please specify) _____

Child's early reading engagement before <ISCED 1>

Childcare before <ISCED 0>

Q2 **Did your child participate in < child care > before <ISCED 0>?**
(Please tick only one box)

Yes	No
☐1	☐2

Note.

<ISCED 0> - This term refers to programs at the pre-primary, or initial stage of organised instruction. Students typically enter ISCED Level 0 programs between age 3 and 5. For an explanation of ISCED levels, see the annotation to Q7 of the school questionnaire.

Child's reading engagement during <ISCED 1>

Home reading literacy support beginning <ISCED 1>

Q3 **When your child attended the first year of <ISCED 1>, how often did you or someone else in your home undertake the following activities with her or him?**
(Please tick only one box in each row)

		Every day or almost every day	Once or twice a week	Once or twice a month	Never or almost never
a)	Read books	☐1	☐2	☐3	☐4
b)	Tell stories	☐1	☐2	☐3	☐4
c)	Sing songs	☐1	☐2	☐3	☐4
d)	Play with alphabet toys (for example: blocks with letters of the alphabet)	☐1	☐2	☐3	☐4
e)	Talk about things you had done	☐1	☐2	☐3	☐4
f)	Talk about what you had read	☐1	☐2	☐3	☐4
g)	Play word games	☐1	☐2	☐3	☐4
h)	Write letters or words	☐1	☐2	☐3	☐4
i)	Read aloud signs and labels	☐1	☐2	☐3	☐4

Note.

<ISCED 1> - *This refers to primary education which begins between age 5 and 7 and generally lasts four years (e.g. Germany) to six years (most OECD countries). Primary education is designed to provide a sound basic education in reading, writing and mathematics along with an elementary understanding of other subjects. For a detailed definition of ISCED levels, see the annotation to Q7 of the school questionnaire.*

Home language beginning <ISCED 1>

Q4 **In what language did most of the activities in Question 3 take place?**
(Please tick only one box)

<test language> ☐1
Another language ☐2

Note.

For the definition of **<test language>** *see the annotation to Q28 in the student questionnaire.*

Time spent on reading for enjoyment

Q5 **When you are home, how much time do you spend reading for your own enjoyment (e.g. magazines, comics, novels, fiction, non-fiction)?**
(Please tick only one box)

a) More than 10 hours a week ☐1
b) 6-10 hours a week ☐2
c) 1-5 hours a week ☐3
d) Less than one hour a week ☐4

Parent's attitude to reading

Q6 **How much do you disagree or agree with these statements about reading?**
(Please tick only one box in each row.)

		Strongly agree	Agree	Disagree	Strongly disagree
a)	Reading is one of my favourite hobbies	☐ 1	☐ 2	☐ 3	☐ 4
b)	I feel happy if I receive a book as a present	☐ 1	☐ 2	☐ 3	☐ 4
c)	For me, reading is a waste of time	☐ 1	☐ 2	☐ 3	☐ 4
d)	I enjoy going to a bookstore or a library	☐ 1	☐ 2	☐ 3	☐ 4

Home reading resources and support

Home reading resources

Q7 **Which of the following are available to your child in your home?**
(Please tick one box in each row)

		Yes	No
a)	Email	☐ 1	☐ 2
b)	<Chat on line> / <MSN >	☐ 1	☐ 2
c)	Internet connection	☐ 1	☐ 2
d)	Daily newspaper	☐ 1	☐ 2
e)	A subscription to a journal or magazine	☐ 1	☐ 2
f)	Books of his/her very own (do not count school books)	☐ 1	☐ 2

Home reading literacy support at age 15

Q8 **How often do you or someone else in your home do the following things with your child?**
(Please tick only one box on each row)

		Never or almost never	Once or twice a month	Once or twice a week	Every day or almost every day
a)	Discuss political or social issues	☐ 1	☐ 2	☐ 3	☐ 4
b)	Discuss books, films or television programmes	☐ 1	☐ 2	☐ 3	☐ 4
c)	Discuss how well your child is doing at school	☐ 1	☐ 2	☐ 3	☐ 4
d)	Eat <the main meal> with your child around a table	☐ 1	☐ 2	☐ 3	☐ 4
e)	Spend time just talking to your child	☐ 1	☐ 2	☐ 3	☐ 4
f)	Go to a bookstore or library with your child	☐ 1	☐ 2	☐ 3	☐ 4
g)	Talk with your child about what he/she is reading on his/her own	☐ 1	☐ 2	☐ 3	☐ 4
h)	Help your child with his/her homework	☐ 1	☐ 2	☐ 3	☐ 4

Parent's educational status

Father's education

Q9 **Does the child's father have any of the following qualifications?**
(Please tick one box in each row)

		Yes	No
a)	<ISCED level 5A, 6>	☐ 1	☐ 2
b)	<ISCED level 5B>	☐ 1	☐ 2
c)	<ISCED level 4>	☐ 1	☐ 2
d)	<ISCED level 3A>	☐ 1	☐ 2

Note.
For a definition of ISCED levels, see the annotation to Q7 of the school questionnaire.

Mother's education

Q10 **Does the child's mother have any of the following qualifications?**
(Please tick one box in each row)

		Yes	No
a)	<ISCED level 5A, 6>	☐ 1	☐ 2
b)	<ISCED level 5B>	☐ 1	☐ 2
c)	<ISCED level 4>	☐ 1	☐ 2
d)	<ISCED level 3A>	☐ 1	☐ 2

Note.
For a definition of ISCED levels, see the annotation to Q7 of the school questionnaire.

Parents' economical status

Annual household income

Q11 **What is your annual household income?**
Please add together the total income, before tax, from all members of your household. Please remember we ask you to answer questions only if you feel comfortable doing so, and that all responses are kept strictly confidential.
(Please tick only one box.)

Less than < $A > ☐ 1
< $A > or more but less than < $B > ☐ 2
< $B > or more but less than < $C > ☐ 3
< $C > or more but less than < $D > ☐ 4
< $D > or more but less than < $E > ☐ 5
< $E > or more ☐ 6

Note.
<$> - This symbol denotes the national currency of the participating country or economy.
<$C> is a suitably rounded value for the national median household income. For all households in the country, the median income is the amount for which half of the households have an income above this amount, and half, below.
<$A>** is a suitably rounded value equal to about half of the median household income, **<$B> is a value at about three quarters of the median household income, **<$D>** is a value at about five quarters of the median household income, and **<$E>** is a value at about one-and-a-half times the median household income.

As an example, a country where the median household income is $40 500 would have the following brackets:
Less than $20 000;
$20 000 or more but less than $30 000;
$30 000 or more but less than $40 000;
$40 000 or more but less than $50 000;
$50 000 or more but less than $60 000;
$60 000 or more

Costs of educational services

Q12 *Please answer the following question thinking just of expenses related to <the student who brought this questionnaire home>.*

In the last twelve months, about how much would you have paid to educational providers for services?

In determining this, please include any tuition fees you pay to your child's school, any other fees paid to individual teachers in the school or to other teachers for any tutoring your child receives, as well as any fees for cram school.

Do not include the costs of goods like sports equipment, school uniforms, computers or textbooks if they are not included in a general fee (that is, if you have to buy these things separately).

(Please tick only one box)

Nothing	☐ 1
More than $0 but less than < $W >	☐ 2
< $W or more but less than $X>	☐ 3
< $X or more but less than $Y>	☐ 4
< $Y or more but less than $Z >	☐ 5
< $Z > or more	☐ 6

Note.

<$> - This symbol denotes the national currency.
<$Z> is a suitably rounded value representing an amount of money that could be spent on an expensive education, including tutoring etc. About 5% of parents should choose this option in a national sample.
<$W> is a suitably rounded value for a public education without any extra tutoring. Where public education is absolutely free, this would be set at a low nominal value but above zero (*e.g.* 50 or 100 Euro) to take account of incidental fees that might be paid.
After determining **<$Z>** and **<$W>**, equal categories are created between these figures to determine values for **<$X>** and **<$Y>**.

Number of children in the household

Q13 **How many children are there in your household (including <the student who brought this questionnaire home>?**

(Please tick only one box)

	Yes	No
On (*i.e.* <the student who brought this questionnaire home>)	☐ 1	☐ 2
Two	☐ 1	☐ 2
Three	☐ 1	☐ 2
Four	☐ 1	☐ 2
Five	☐ 1	☐ 2
Six or more	☐ 1	☐ 2

Parents' perception of and involvement in school

Parents' perception of school quality

Q14 **How much do you agree or disagree with the following statements?**
(Please tick only one box in each row)

		Strongly agree	Agree	Disagree	Strongly disagree
a)	Most of my child's school teachers seem competent and dedicated	☐1	☐2	☐3	☐4
b)	Standards of achievement are high in my child's school	☐1	☐2	☐3	☐4
c)	I am happy with the content taught and the instructional methods used in my child's school	☐1	☐2	☐3	☐4
d)	I am satisfied with the disciplinary atmosphere in my child's school	☐1	☐2	☐3	☐4
e)	My child's progress is carefully monitored by the school	☐1	☐2	☐3	☐4
f)	My child's school provides regular and useful information on my child's progress	☐1	☐2	☐3	☐4
g)	My child's school does a good job in educating students	☐1	☐2	☐3	☐4

Parents' involvement in their child's school

Q15 **The last <academic year>, have you participated in any of the following school-related activities?**
(Please tick one box in each row)

		Yes	No
a)	Discuss your child's behaviour or progress with a teacher on your own initiative	☐1	☐2
b)	Discuss your child's behaviour or progress on the initiative of one of your child's teachers	☐1	☐2
c)	Volunteer in physical activities, *e.g.* building maintenance, carpentry, gardening or yard work	☐1	☐2
d)	Volunteer in extra-curricular activities, *e.g.* book club, school play, sports, field trip	☐1	☐2
e)	Volunteer in the school library or media centre	☐1	☐2
f)	<Assist a teacher in the school>	☐1	☐2
g)	Appear as a guest speaker	☐1	☐2
h)	Participate in local school <government>, *e.g.* parent counsel or school management committee	☐1	☐2

Note.
<Last academic year> - refers to the previous year of schooling, which is not necessarily the last calendar year.

School choice

Choice between competing schools

Q16 We are interested in the options parents had when choosing the school your child is currently attending.

Which of the following statements best describes the schooling available to students in your location?

(Please tick only one box)

There are two or more other schools in this area that compete with the school my child is currently attending ☐1

There is one other school in this area that competes with the school my child is currently attending ☐2

There are no other schools in this area that compete with the school my child is currently attending ☐3

Reasons for school choice

Q17 **How important are each of the following reasons for choosing a school for your child?**

(Please tick only one box in each row)

		Not important	Somewhat important	Important	Very important
a)	The school is at a short distance to home	☐1	☐2	☐3	☐4
b)	The school has a good reputation	☐1	☐2	☐3	☐4
c)	The school offers particular courses or school subjects	☐1	☐2	☐3	☐4
d)	The school adheres to a particular <religious philosophy>	☐1	☐2	☐3	☐4
e)	The school has a particular pedagogical-didactical approach, *e.g.* < example>	☐1	☐2	☐3	☐4
f)	Other family members attended the school	☐1	☐2	☐3	☐4
g)	<Expenses are low> (*e.g.* tuition, books, room and board)	☐1	☐2	☐3	☐4
h)	The school has financial aid available, such as a school loan, scholarship, or grant	☐1	☐2	☐3	☐4
i)	The school has an active and pleasant school climate	☐1	☐2	☐3	☐4
j)	The academic achievements of students in the school are high	☐1	☐2	☐3	☐4

ANNEX C

PISA expert groups

Annex C lists the experts who were involved in creating and implementing the PISA 2009 survey. They specialise in reading, mathematics and science, as well as questionnaire development and carrying out large-scale education-related international surveys.

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