ISA

International Schools' Assessment

How the ISA aligns with the IB curriculum

Australian Council *for* Educational Research

ACER

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Introduction

More than two-thirds of ISA schools use an International Baccalaureate (IB) component in their curriculum. This document shows how the ISA assessments can be broadly aligned with the PYP and MYP Curricula.

The ISA assesses mathematical literacy, reading, writing and scientific literacy using the internationally-endorsed frameworks from the Programme for International Student Assessment (PISA). The ISA items address the extent to which an individual student can mobilise their knowledge in a domain to solve authentic problems. The ISA does not assess performance against a particular curriculum, and it is not designed to address the full scope of the curriculum in mathematics, reading, writing and science for any school. It addresses as broad a range of key skills and understandings as is possible in a short, standardised test. Matching the ISA items to the PYP or MYP curricula must always be done with the understanding that not all of the curriculum will be addressed by the ISA.

To assist teachers in the diagnostic interpretation of the ISA data, the ISA class report provides a description of the key skills addressed by each item. This allows teachers to interpret and explain student performance for each item.

The items in each test are also classified into several broad groups to allow teachers to interpret and explain student performance in a group of related skills. The PYP and MYP curricula are divided into strands. The PISA classifications used by the ISA can be broadly mapped to each other, although the match is not perfect. The purpose of this document is to show the match between the ISA/PISA classifications used to group items in the ISA class reports with the PYP and MYP strands for mathematics and the PYP scope and sequence chart for reading. Similarities between the ISA writing construct and that of PYP and MYP is also shown.

Mathematical Literacy

Each task in the ISA Mathematical Literacy assessment is defined according to its content and the type of process needed to complete it successfully. Process variables describe the typical stages of mathematical thought and action that are needed to solve mathematical problems (See Appendix A).

ISA content variables: Uncertainty and Data, Quantity, Space and Shape, Change and Relationships

ISA process variables: Formulating, Employing, Interpreting

It is relatively straightforward to match the ISA content variables to the PYP and MYP strands. The main differences are in terminology. The ISA process variables are also fairly well-aligned to the MYP Mathematics Assessment Criteria and the PYP description of the 'stages through which children learn mathematics'.

PYP and ISA Content Variables

Table 1 - Content comparisons between ISA and PYP mathematics

ISA Content Variable	PYP Strand
Uncertainty and Data	Data Handling
Quantity	Number and Measurement
Space and Shape	Shape and Space
Change and Relationships	Pattern and Function

As is evident in Table 1, the terms used vary, but the match is reasonably close. One point of difference between ISA and PYP classifications is that the two distinct strands in PYP mathematics - Number and Measurement - align neatly with one ISA content variable: Quantity.

PYP and ISA Process Variables

The PYP mathematics curriculum has not been classified according to the processes students use to solve problems. However, there are some references to these skills. In the PYP description of 'how best will students learn', the kind of mathematical reasoning described seem to coincide with the three PISA process categories as shown in Table 2 on the next page:

Table 2 - Process comparisons between ISA and PYP mathematics

ISA Content Variable	PYP Stages
Formulating	Constructing meaning Transferring meaning into signs and symbols
Employing	Understanding and Applying
Interpreting	Understanding and Applying

The key difference between Employing and Interpreting in the context of PYP is as follows:

Employing mathematics involves applying mathematical procedures to find a mathematical solution. It involves working within a context that has already been formulated mathematically and therefore does not need explicit translation between the mathematically formulated situation and the real-life problem. Typical actions would include manipulating numbers, applying mathematical facts, rules and algorithms, and extracting data from mathematical diagrams, graphs and constructions.

Interpreting mathematics involves reflecting upon mathematical solutions or results and interpreting them in the context of a real-life problem or challenge. It includes evaluating whether a mathematical result is reasonable in the context of a real-world problem, making contextual judgments about how a mathematical result should be adjusted or applied, and recognising underlying assumptions and limitations of the mathematical model used to solve a problem.

MYP and ISA Content Variables

Table 3 - Content comparisons between ISA and MYP mathematics

ISA Content Variable	MYP Branch
Uncertainty and Data	Reasoning with data
Quantity	Numerical and abstract reasoning
Space and Shape	Spatial reasoning
Change and Relationships	Numerical and abstract reasoning Thinking with models

In Table 3 the terms used vary, but the match is reasonably close. The MYP Mathematics curriculum integrates content with reasoning

It should be noted that, as in all such constructs, the division between variables is somewhat arbitrary and there is much overlap. For instance, many algebraic and geometric calculations rely heavily on knowledge and skills from the Quantity variable.

MYP and ISA Process Variables

The ISA process variables (Formulating, Employing, Interpreting/Evaluating) have parallels with the MYP Mathematics Assessment Criteria: Knowing and Understanding; Investigating Patterns; Communicating; and Applying Mathematics in Real-Life Contexts.

Knowing and Understanding aligns most closely with the Employing process variable e.g. ‘using numeric, algebraic, graphical and other forms of representations’ and ‘moving between different forms of representations’; although there may be some elements of interpreting as well e.g. ‘using knowledge and understanding to make deductions’.

Investigating Patterns aligns with all three process variables of the ISA/PISA framework. Formulating would align with ‘apply mathematical problem-solving techniques to recognize patterns’; while ‘describe patterns as relationships or general rules consistent with correct findings ’ might include elements of Formulating and Interpreting/evaluating; and ‘verify whether the pattern works for other examples ’ could involve mainly Employing and Interpreting/evaluating.

Communicating includes encoding and decoding, describing in words a line of reasoning, explaining solutions, and presenting mathematical information clearly and logically. These primarily match the Formulating and Interpreting process variables. Formulating involves translating a problem in context into a form amenable to mathematical manipulation (moving from the ’real world’ to the ’mathematical world’), whereas Interpreting involves translating a purely mathematical solution so that it makes sense within the contextual framework of the question (moving from the ‘mathematical world’ to the ‘real world’).

Applying mathematics in real-life contexts involves identifying relevant elements of authentic real-life situations, selecting appropriate mathematical strategies when solving authentic real-life situations, applying the selected mathematical strategies to reach a solution, and describing whether a solution makes sense in the context of the authentic real-life situation, and is primarily linked to the Formulating and Interpreting process variables.

The skills component of the MYP mathematics curriculum could also be matched to the ISA/PISA process variables. The following are some instances:

Formulating - Drawing and interpreting Venn diagrams, Forming equations; Flowcharts, Correlation, Qualitative handling of probability, Representing and solving compound and double inequalities, Predicting the next term in a number sequence (linear, quadratic, triangular, Fibonacci), Constructing and interpreting graphs, Selecting samples and making inferences about populations

Employing - Transformation between different forms of numbers, Simplification of numerical expressions in the number systems and forms of number, Recognizing and classifying numbers in different number systems, including recurring decimals, Using the four number operations (addition, subtraction, multiplication and division) with integers, decimals and fractions, Negative exponents, Function notation, Naming and classifying different geometrical elements (point, line, plane, angle, regular and irregular planar figures, solids).

Interpreting – Time zones, clocks and timetables, Tessellations, Mappings, Bearings, Calculating the mean, median and mode, and choosing the best measure of central tendency, Cumulative frequency graphs, Surface area and nets, Bar charts, stem and leaf, pictograms, Data visualizations and infographics, Limitations and context in statistical enquiry.

Reading

Reading literacy in PISA is defined as '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.' While this definition and the construct of reading that grew out of it were developed with 15-year-olds in mind, the ISA construct of reading maintains the general thrust of a reading assessment that goes beyond the notion of decoding and literal comprehension (though at the lowest levels these are included), and recognises the full scope of situations in which reading plays a role for students from Grade 3 to Grade 10.

Each Reading task in the ISA is defined in terms of the aspect or approach to reading that it requires, and according to the text format of the reading passage on which the task is based.

Aspect Variables

Access and Retrieve (AR) is defined as locating one or more pieces of information in a text.

Integrate and Interpret (II) is defined as constructing meaning and drawing inferences from one or more parts of a text.

Reflect and Evaluate (RE) is defined as relating a text to one's experience, knowledge and ideas.

Text Format Variables

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. Continuous texts include narrative pieces, exposition, description, argument and instructional passages.

Non-Continuous Texts, or 'documents' as they are known in some frameworks, consist of information presented in one or more lists or a more visual format that does not consist of sentences.. In less formal terms, they can be described by their everyday appearance in such formats as tables, graphs, maps and diagrams.

PYP and the ISA Reading Aspects

The PYP language scope and sequence chart does not classify reading by aspect or text format. Curriculum expectations for reading are grouped in relation to sample activities for each level of the PYP. Some the PYP expectations are suited to assessment in a pen and paper test and fit the PISA construct. Other expectations focus on reading strategies and reading activities that are not readily addressed by a pen and paper test. These expectations, and the expectations of students aged 3-5 years, are not considered here.

On the next page, Table 4 shows one possible way of grouping those PYP expectations that can be addressed by the ISA. Many of the expectations fit under the PISA classifications of Interpreting or Reflecting. The two classifications of Form & Structure and Author's Purpose have been separated out. Under the PISA construct these kinds of skills would be categorised as **Reflecting** if the student was required to draw on outside knowledge, and **Interpreting** if the question focused on the meaning of the content of the text.

Table 4 – PYP Reading Aspects

Age	Access and Retrieve (AR)	Integrate and Interpret (II)	Reflect and Evaluate (RE)	Form and Structure	Author's Purpose
5-7 years		Predict what might happen next in a story	Identify with a character or situation	Recognise that a story has a beginning, middle and an ending	Understand the role of an author or illustrator
		Know the difference between fiction and non-fiction	Understand and respond to the ideas and feelings expressed in various reading materials	Recall plot and characters of a story	
				Recognise and talk about a range of different text forms	
7-9 years	Read quickly and scan to find specific information	Make inferences and be able to justify them	Understand and respond to the ideas, feelings and attitudes expressed in various texts	Identify and describe the elements of a story (setting, plot, characters and theme)	Begin to recognise the author's purpose (to inform, persuade, entertain, instruct)
		Respond to texts by identifying the main idea, recognising cause and effect, distinguishing between fact and opinion, questioning and drawing conclusions	Begin to understand that texts may be interpreted differently by different people	Recognise that there are more complex story structures than beginning, middle and end	

Age	Access and Retrieve (AR)	Integrate and Interpret (II)	Reflect and Evaluate (RE)	Form and Structure	Author's Purpose
9-12 years	Locate and access information from a variety of sources	Recognise and understand figurative language (e.g. similes, metaphors, idioms) Show awareness that poems have layers of meaning Understand that words can evoke mental images Organise and synthesise information from a variety of sources Use specific vocabulary to comment on and analyse poetry	Generate new questions after reading and connect these to prior knowledge and experience Critically evaluate their own choices in books Be aware that poems are open to a range of interpretations	Identify the elements of plot and the pattern in story outline Categorise literature into type and genre Identify the five basic types of conflict in a story Identify and discuss forms and structures	Infer the author's purpose

The ISA text format classifications match the general expectation of the PYP and MYP that students read a range of different text types.

MYP and the ISA Reading Aspects

The MYP does not have a scope and sequence chart for **Language A**. The ISA/PISA aspects provide teachers with diagnostic information that can be aligned with the MYP final objectives.

Writing

The ISA Writing construct supports a developmental approach to writing that recognises early through to mature writing skills. In ISA Writing, the scoring and reporting scheme that has evolved is similar to that used in the International Baccalaureate PYP and MYP, and the AERO standards for writing. It also references well-known writing frameworks such as the McRel Standards, the Alberta writing program, and the Six Traits of Writing (Ideas, Organisation, Word Choice, Sentence Fluency, Voice, Conventions).

The ISA Writing construct is similar to that of PYP and MYP in that students learn to use language in a variety of ways to suit different intentions, audiences and contexts, as they do in PYP and MYP. They learn to vary their content, organizational strategies, sentence structure, tone, and word choice depending on their chosen purpose and audience elicited by the given writing prompts. The MYP Language and Literature pilot guide states that students are taught with the aim that they will 'create works that demonstrate insight, imagination and sensitivity' and these writing qualities are definitively emphasized in the detailed ISA criteria.

The ISA Writing assessment includes two extended writing tasks: one narrative/reflective task and one exposition/argument task. For the narrative/reflective task the students are asked to write a story, or a reflective piece. The exposition/argument task requires a piece of writing setting out ideas about a proposition. In the latter, students may take an explanatory approach (exposition), a persuasive approach (argument), or they may combine the two approaches.

Each writing task is scored on three major criteria, as summarised in the below table.

Table 5 – Writing Criteria

Narrative/Reflective Writing	
Content	This criteria includes consideration of the quality and range of ideas, development of plot, characters and setting, the writer's sense of audience and purpose, and the overall shape of the writing.
Language	This includes consideration of sentence and paragraph structure, vocabulary and punctuation, and the writer's voice.
Spelling	This includes consideration of phonetic and visual spelling patterns and the kind of words attempted, and correctness.

Exposition/Argument Writing	
Content	This includes consideration of the depth and range of ideas, the quality of the reasoning demonstrated, the ability to provide evidence and the presence of logical argument in support of a position.
Language (ESOL)	Because of the high number of ISA students who have a language background other than English, the Language criterion for this task considers ESOL Language features and it is scored by considering grammatical correctness and command of English syntax, sentence fluency and variation, and vocabulary use (applied to all students' writing regardless of their language background).
Structure	Consideration is given to the overall global structure, e.g. presence of a clear introduction, development and conclusion. The internal coherence of the piece is assessed, such as the linking between and within paragraphs.

The two writing tasks of the ISA aim to capture students' abilities to analyse, to reflect, to develop arguments and be creative. This design reflects the PYP and MYP aims regarding range and content of student writing. Through the reporting on each of the criteria outlined in the table above, ISA Writing provides teachers with detailed diagnostic information for individual students that can be aligned with the PYP and MYP English Language Arts standards.

Scientific Literacy

In terms of their approach towards Science and Scientific Literacy, the ISA Science framework and the IB PYP and MYP curricula have much in common. Although there are differences in terminology, the content and processes described in each of these frameworks clearly correspond to each other.

The ISA adopts the PISA definition that 'Scientific Literacy is the ability to engage with science-related issues, and with the ideas of science as a reflective citizen' (OECD 2019, p.100) and 'is defined by the three competencies of: explaining phenomena scientifically; evaluating and designing scientific enquiry; and interpreting data and evidence scientifically.' (OECD 2019, p. 99) The IB-MYP Science program expresses the following very similar philosophy:

> *With inquiry at the core, the MYP sciences framework aims to guide students to independently and collaboratively investigate issues through research, observation and experimentation. The MYP sciences curriculum must explore the connections between science and everyday life. As they investigate real examples of science applications, students will discover the tensions and dependencies between science and morality, ethics, culture, economics, politics, and the environment.*
>
> *(Sciences Guide 2014, p4)*

The IB's focus on 'structured inquiry in the context of interdisciplinary units' (Sciences Guide 2014, p5) matches well with the ISA approach of presenting a stimulus in an authentic context and having learners interpret the given stimulus in light of their scientific knowledge and process skills. Similarly, for PYP, Science knowledge and skills are embedded within trans-disciplinary programs.

Scientific Terminology in ISA compared to IB

The framework of ISA Science is based on the PISA 2015/2018 Scientific Literacy framework (OECD 2019). Each task in the ISA scientific literacy assessment is classified by competency and knowledge type. The competencies and knowledge types are further described in Appendix B.

Competency variables describe typical types of scientific thought and action. The competency variables are:

- Evaluate and design scientific enquiry
- Explain phenomena scientifically
- Interpret data and evidence scientifically

Knowledge types relate to the content of the science (disciplinary knowledge about the natural world and technology) and to the processes of science (scientific investigations and procedures and scientific reasoning). The knowledge types are:

- Content knowledge (Physical Systems, Living Systems, Earth and Space Systems)
- Procedural knowledge
- Epistemic knowledge

The following tables show how the terminology used in the IB MYP curriculum corresponds to the ISA framework.

Table 6 – Comparisons between MYP Objectives and ISA knowledge types and competencies

MYP Objective	ISA competency	ISA knowledge type
Knowing and understanding	Explain phenomena scientifically	Content knowledge
Inquiring and designing	Evaluate and design scientific enquiry	Procedural knowledge Epistemic knowledge
Processing and evaluating	Interpret data and evidence scientifically Evaluate and design scientific enquiry	Procedural knowledge Epistemic knowledge
Reflecting on the impacts of science	Evaluate and design scientific enquiry	Procedural knowledge Epistemic knowledge

Table 7 – Comparisons between MYP Sciences and ISA content knowledge areas

MYP Science	Corresponding ISA content area
Biology	Living systems
Chemistry	Physical systems
Physics	Physical systems
Earth science	Earth and Space systems
Astronomy	Earth and Space systems
Environmental science	Earth and Space systems Living systems
Sport science	Living systems Physical systems
Health science	Living systems Physical systems

Table 8 – Comparisons between PYP science skills and ISA competencies and knowledge types

PYP Science skills	ISA competency	ISA knowledge type
Observe carefully in order to gather data	Evaluate and design scientific enquiry	Procedural knowledge
Use a variety of instruments and tools to measure data accurately	Evaluate and design scientific enquiry	Procedural knowledge
Use scientific vocabulary to explain their observations and experiences	Explain phenomena scientifically	Content knowledge
Identify or generate a question or problem to be explored	Evaluate and design scientific enquiry	Epistemic knowledge
Plan and carry out systematic investigations, manipulating variables as necessary	Evaluate and design scientific enquiry	Procedural knowledge
Make and test predictions	Evaluate and design scientific enquiry	Procedural knowledge Epistemic knowledge
Interpret and evaluate data gathered in order to draw conclusions	Interpret data and evidence scientifically	Content knowledge Epistemic knowledge
Consider scientific models and applications of these models (including their limitations)	Evaluate and design scientific enquiry	Content knowledge Epistemic knowledge

Table 9 – Comparisons between PYP science strands and ISA content areas

PYP science strand	Corresponding ISA content area
Living things	Living systems
Materials and matter	Physical systems
Forces and energy	Physical systems
Earth and space	Earth and Space systems

One key difference between the organisation of PYP content and MYP content compared to ISA is that Chemistry (Materials and matter in PYP) and Physics (Forces and energy in PYP) are separate disciplines in the IB, but are both classified as Physical systems in ISA.

To determine whether a Physical systems item in the ISA report is related to Physics or Chemistry, teachers should look at the details in the associated item descriptor.

For example, both of these are descriptors of Physical systems items:

1. Identify atmospheric friction as a significant force opposing motion.
2. Identify the source of the bubbles in a carbonated drink.

Descriptor 1 is related to Physics (Forces and energy) and Descriptor 2 is related to Chemistry (Materials and matter).

References

- OECD (2019),PISA 2018 Assessment and Analytical Framework, PISA, OECD Publishing, Paris, https://doi.org/10.1787/b25efab8-en
- The International Baccalaureate Organisation (2008). *Primary Years Program. Science Scope and Sequence*: International Baccalaureate: Wales, UK. Accessed from http://www.gjovikis.no/wp-content/uploads/2015/11/SCIENCE.pdf

APPENDIX A – Mathematical Literacy

ISA/PISA Mathematical Literacy Content variables

Uncertainty and Data - This content area reflects how real life data is commonly collected, organised, analysed and displayed with a view to making interpretations and forming conclusions. Many decisions are made on the basis of statistical analysis of data. Real life also contains elements of chance where outcomes are not certain but based upon probabilities. Increasingly decision-making is qualified with a statement of risk and society is presented with more and more information to make sense of, so competence in this area is of great significance.

Quantity - This overarching content area also features in the three other content areas to varying degrees. It focuses on the need for quantification in order to organise the world. It is not hard to find examples of quantification in our day-to-day living. We use money, make measurements, estimate and calculate. Increasingly we make use of technology to assist us but we also still perform many calculations mentally and approximately. Quantitative reasoning requires number sense: that is, having a feel for the magnitude of numbers, using strategies and tools appropriately, and being able to check solutions for reasonableness.

Space and Shape - Shapes and constructions are all around us physically as real objects but also as representations in the form of photographs, maps and diagrams. Constructing and interpreting such representations is an important skill. Using geometric shapes whose mathematical properties are known to model more complex shapes is an important problem-solving tool. Knowledge and appreciation of the beauty and function of geometric shapes and spaces has applications reaching from art to advertising.

Change and Relationships - Noticing and using patterns in number and shapes, and finding and describing relationships between variables, lies at the heart of mathematics. As organisms or populations grow and as stock markets ebb and flow, we describe the patterns in words, in tables and sometimes in algebraic notation. Commonly we chart the changes in graphical form. These patterns can be linear, non-linear, cyclic or exponential, to name but a few. Being able to link between these various representations and use the language, notation and algorithms of change and relationships is critical to making sense of the patterns in our world.

ISA/PISA Mathematical Literacy Process variables

A second set of variables upon which the ISA mathematics testing is constructed is the 'process variables'. There are three process variables in ISA:

Formulating mathematics involves identifying opportunities to apply and use mathematics. It includes being able to take a situation as presented and transform it into a form amenable to mathematical treatment, providing mathematical structure and representations, identifying variables and making simplifying assumptions to help solve the problem or meet the challenge.

Employing mathematics involves applying mathematical reasoning and using mathematical concepts, procedures, facts and tools to derive a mathematical solution. It includes performing calculations, manipulating algebraic expressions and equations or other mathematical models, analysing information in a mathematical manner from mathematical diagrams and graphs, developing mathematical descriptions and explanations and using mathematical tools to solve problems.

Interpreting mathematics involves reflecting upon mathematical solutions or results and interpreting them in the context of a problem or challenge. It includes evaluating mathematical solutions or reasoning in relation to the context of the problem and determining whether the results are reasonable and make sense in the situation.

APPENDIX B – Reading Literacy

Aspect Variables

- Access and Retrieve (AR) is defined as locating one or more pieces of information in a text.
- Integrate and Interpret (II) is defined as constructing meaning and drawing inferences from one or more parts of a text.
- Reflect and Evaluate (RE) is defined as relating a text to one's experience, knowledge and ideas.

Text Format Variables

- 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. Continuous texts include narrative pieces, exposition, description, argument and instructional passages.
- Non-Continuous Texts, or 'documents' as they are known in some frameworks, consist of information presented in one or more lists or a more visual format that does not consist of sentences. In less formal terms, they can be described by their everyday appearance in such formats as tables, graphs, maps and diagrams.

APPENDIX C – Scientific Literacy

Competency variables

Evaluate and design scientific enquiry

This competency focuses on the ability to understand the goals and processes of scientific enquiry in generating empirical data and reliable knowledge about the natural world. Awareness is needed of methods of data collection by observation or experiment, in the laboratory or in the field and how this leads to the development of models and hypotheses. Skills demonstrated by those with this competency include the identification of questions that can be explored scientifically; proposal and evaluation of methods for exploring a given question scientifically; and awareness of the methods used by scientists to ensure reliability of data, to acknowledge and minimise measurement error; and ensure conclusions are objective and can be generalised.

Explain phenomena scientifically

Demonstrating this competency involves recall and application of appropriate scientific knowledge in a given situation. The competency includes describing or interpreting phenomena and predicting changes. It also involves explaining the societal implications of scientific knowledge and may involve recognising or identifying appropriate descriptions, explanations, hypotheses and predictions.

Interpret data and evidence scientifically

Analysing and evaluating scientific data and evidence in a variety of situations are the main areas emphasised in this competency. Some key aspects of this competency include transforming data from one representation to another; and evaluating scientific arguments, assumptions, evidence and reasoning from different sources (e.g. websites, journals, newspapers, science-related texts). Students may be required to present evidence and decisions through their own words, diagrams or other representations as appropriate. Students are required to make clear and logical connections between evidence and conclusions or decisions.

Knowledge types

Content knowledge involves students applying knowledge appropriate to the developmental level of 9–16 year-olds in the key scientific content areas of physics; chemistry; biology; and earth & space science. This knowledge is presented in contexts of relevance to real-life situations.

The three key categories of Content knowledge are:

- **Physical systems** which includes the structure and properties of matter, the nature of chemical change, energy and its transformations, motion and forces and the interactions of energy and matter.

- **Living systems** which includes the structure and function of living things; human body systems; evolution; biodiversity; genetic variation; ecosystems and knowledge of the conditions necessary for sustaining life.
- **Earth and space systems** which includes structure of the Earth (e.g. lithosphere, atmosphere and hydrosphere); energy sources for the Earth; global climate; forces that shape the Earth such as plate tectonics; geochemical cycles; constructive and destructive forces; Earth history such as origin, evolution and the study of fossils; and Earth in space (e.g. solar system, gravity).

Procedural knowledge is about the various components of the scientific process (also known as the scientific method). This includes knowledge and awareness of:

- variables including dependent, independent and control variables;
- principles of measurement (inherent uncertainty, replicability, accuracy/precision etc.);
- common ways of representing data using tables, graphs and charts and deciding which are appropriate in a given context; and
- appropriate methods to investigate a scientific question such as experimental or field-based studies

Epistemic knowledge involves recognition of the defining features of Science.

This includes:

- the ability to recognise and distinguish between observations, facts, hypotheses, models and theories;
- recognition of the difference in purposes and goals between Science and Technology;
- identification of scientific values such as the importance of objectivity and the commitment to elimination of bias;
- recognition of the type of reasoning inherent in scientific argumentation, e.g. use of deduction, induction, analogy, inference, analogy or modelling
- how the values, constructs and features of science and scientific reasoning can be used to justify the knowledge produced by Science
- the role of collaboration, critique and peer review in building scientific knowledge