ESSA FRAMEWORK

ESSA level	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6
Strands	**Descriptors**					
PFA **4.1–4.5** This strand assesses students' capacity to use knowledge and understandings of the history, nature, practice and applications of science as well as their understanding of the impact of science on society, on technology and on the environment.	Identifies a scientific discovery		Explains that a model is a representation of a concrete object or an idea	Outlines the historical development of a model or theory	Describes examples where scientific understanding has changed	Uses evidence to support or criticise a scientific model, theory or law
	Identifies a technology	Identifies experiences and events that have a scientific component	Explains a link between technology and science	Identifies an impact of science/technology on society or the environment		Relates an application of science and its impact on society or the environment
	Identifies a possible career path in science	Identifies a science context in a career		Identifies science as a human activity Identifies scientific evidence		Discusses the choices people make regarding science, technology and society
Knowledge and understanding **4.6–4.12** This strand assesses students' capacity to use knowledge and understandings of the fundamental concepts and processes of science.	Identifies a simple structure/process of our world or space	Describes simple structures/processes of our world or space	Relates simple structures/processes of our world or space	Describes a complex structure/process of our world or space		Explains physical phenomena using a model, theory or law
	Identifies one function of a simple structure/process of our world or space	Identifies a structure/process and its function within a system		Describes the function of a structure/process within a system	Describes functions of structures/processes within a system	Relates the functions of structures within a system
			Relates a model to an aspect of our world or space	Describes a law	Describes a model or theory	Discusses benefits and limitations of using models, theories and laws
				Identifies an interaction of systems or within a system	Describes interactions of systems or within systems	Explains the interaction of complex systems

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Strands	**Descriptors**					
Planning and conducting investigations **4.13–4.15** This strand assesses students' capacity to formulate or identify questions and hypotheses, plan investigations and collect evidence.				Identifies a variable of a controlled experiment/ investigation	Describes the variables of a controlled experiment/ investigation	Relates the dependent and independent variables for a given problem
		Identifies questions that can be tested scientifically		Describes one way to improve the reliability of a controlled experiment/ investigation	Identifies ways to improve the reliability and accuracy of controlled experiments/ investigations	Evaluates and modifies experimental procedures
		Identifies features of a scientific test	Identifies the purpose of a fair test	Identifies a prediction, inference, conclusion, aim and hypothesis		Explains what constitutes a controlled experiment
	Identifies a familiar unit	Identifies units of fundamental quantities	Records measurements including units			Explains the selection of an appropriate unit
	Makes a simple observation				Accurately and systematically records observations and data	Discusses the relationship between accuracy and reliability
		Identifies equipment for a simple task	Relates equipment and appropriate use for a simple task	Selects one piece of appropriate scientific equipment for a task		Justifies selection of equipment
	Identifies an unsafe activity in the classroom or playground		Relates safety procedures to dangers	Identifies a potential hazard of an investigation		Relates hazards to the nature of materials or situations

ESSA level	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6
Strands	**Descriptors**					
Communicating **4.16, 4.17a–d, 4.18** This strand assesses students' skills in locating, referencing and organising data and information and the use of appropriate text for purpose and audience.	Locates one piece of information in a simple table or graph Locates one piece of information directly stated in a diagram or other text	Locates information in a complex table, graph or text Locates information not directly stated in a diagram or other text	References information within a diagram, table, graph or other text		Extracts related information from diagrams, tables, graphs or other texts Compares two sets of information	
		Identifies issues or themes in simple text	Identifies the purpose of a simple text	Identifies an issue or a theme in a complex text Identifies the intended audience for a complex text	Identifies the varied purposes of a complex text	Explains the theme and function of a complex text
	Uses a simple key or symbol to represent a concrete object or representation		Completes diagrams and symbolic representations			Represent relationships using keys, symbols and flowcharts
	Identifies a type of graph	Draws column, bar and line graphs with axes provided		Draws a line graph		Selects and uses appropriate graphs
		Places data to complete a provided table or scaffold	Organises a set of data			
				Identifies one piece of relevant scientific information	Identifies relevant and irrelevant scientific information	

ESSA level	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6
Strands	**Descriptors**					
Critical thinking 4.17e–g, 4.19–4.21 This strand assesses students' skills in identifying issues and problems, using critical thinking skills in drawing evidence-based conclusions, framing possible problem-solving processes and developing creative solutions.						Critically analyses the credibility of scientific information
	Identifies an aspect of a trend in data		Describes a trend in data		Applies mathematical models to data	
		Converts units	Explains the ratio of one unit to another		Creates an appropriate scale	
				Identifies a piece of evidence to support claims	Identifies data which supports or discounts a hypothesis	Evaluates evidence and conclusions for reliability and validity
		Makes inferences	Uses cause and effect to explain an observation	Formulates a cause and effect relationship		
		Makes predictions	Draws a simple conclusion	Draws a conclusion based on scientific evidence		Describes the wider significance of conclusions
	Identifies an aspect of a problem	Describes issues surrounding a problem	Explains that a particular problem may have more than one solution	Describes an effective solution to a problem with a science context		Evaluates solutions for a problem against predetermined criteria

ESSA framework syllabus connections

This is a summary of some links between the ESSA framework and the *Science Years 7–10 Syllabus*.

Links with the Domain

A Knowledge and understanding

The syllabus suggests that a cohesive teaching course for Stage 4 in science can be developed by organising knowledge and understanding into:

- **systems**

  The syllabus describes systems such as those where the focus is on the function of the structure or the interactions which take place within it.

  Examples of systems: body systems; chemical reactions; organisms; life cycles; energy systems; solar system; water cycle; rock cycle; an ecosystem

- **structures**

  The syllabus describes structures such as those where the focus is on the organisation of **parts** into a whole.

  Examples of structures: cells; compounds; organs; Earth; matter; a food web

- **interactions**

  The syllabus indicates that scientific concepts do not exist in isolation from each other and that science involves identifying interactions between and within simple and complex systems.

  Examples of interactions between systems: an organism and its ecosystem; living things and their environment (including human's use of resources); transformation of energy; separation of substances

  Examples of interactions with systems: elements with other elements and compounds in chemical reactions; producers and consumers in a food chain; energy transfer

- **models, theories and laws**

  The syllabus describes models as being representations which may be physical, mathematical, experimental or logical. It describes theories as a coherent explanation of a body of experimental evidence, based on a small number of assumptions. It describes a law as a simple and precise statement that has, at one time, been regarded as universally valid.

  Examples of models: Newtonian model of the solar system; particle model of matter; electric current; energy

  Examples of theories: cell theory; kinetic theory

  Examples of laws: law of conservation of energy; Newton's laws

Note that there are other ways to define laws and theories. For instance:

- Laws can be described as statements or descriptions of the relationships between observable phenomena. For example, Boyle's law provides a mathematical relationship between volume and pressure for a gas.
- Theories are often inferred explanations for observable phenomena. For example, the kinetic molecular theory explains Boyle's law.

Adapted from Venville, Grady and Dawson, Vaille (2004). *The Art of Teaching Science.* Sydney: Allen and Unwin

Also note that not all laws and theories fit neatly into this description. Some notable exceptions are the Lowry/Bronsted theory of acids and bases and Avogadro's principle.

Scope of content

The syllabus describes knowledge and understanding in Stage 4 as being about:

- the physical world (such as forces, energy)
- matter (such as states of matter, changes of state, elements, compounds, mixtures)
- the living world (such as classification, unicellular and multicellular organisms, humans, ecosystems, natural resources)
- Earth and space (such as components, structure and natural resources).

The ESSA framework has developed descriptors for the 'Knowing and understanding' strand based on the syllabus explanation of the Domain (knowledge and understanding) and the outcomes and content from 4.6 to 4.12.

B Prescribed Focus Areas (PFAs)

The syllabus describes these as being designed to increase students' understanding of: science as an ever developing body of knowledge; the provisional nature of scientific explanations; the complex relationship between evidence and ideas; the impact of science on society.

Students will develop knowledge and understanding of:

- the history of science
- the nature and practice of science
- the applications and uses of science
- implications of science for society and the environment
- current issues, research and development.

The ESSA framework has developed descriptors for the 'PFA' strand based on the syllabus explanation of the PFAs and the outcomes and content from 4.1 to 4.5.

C Skills

The syllabus states that the study of science provides students with the opportunity to develop skills in working scientifically in:

- planning investigations
- conducting investigations
- communicating information and understanding
- developing scientific thinking and problem-solving techniques.

The ESSA framework has developed descriptors regarding Skills for the 'Communicating' strand using the outcomes and content from 4.16, 4.17a–d and 4.18; for the 'Critical thinking' strand using outcomes and content from 4.17e–g, 4.19, 4.20 and 4.21; for the 'Planning and conducting investigations' strand using outcomes and content from 4.13, 4.14 and 4.15.

Framework strands and syllabus outcomes

The *Science Years 7–10 Syllabus* provides the criteria for the ESSA test. The syllabus outcomes were organised into five strands. The ESSA team conducted an analysis of the syllabus using the 'Structure of observed learning outcome' (SOLO) taxonomy. SOLO enables the description of levels of student responses This analysis highlighted the three dimensional nature of the syllabus. A summary of the syllabus analysis produced the framework. The framework has informed the brief provided to item writers for ESSA and is the basis of the reporting process.

ESSA framework strand	Syllabus outcome focus	ESSA reporting strand
Planning and conducting investigations	4.13, 4.14, 4.15	Working scientifically
Communicating	4.16, 4.17a–d, 4.18	Communicating scientifically
Critical thinking	4.17e–g, 4.19, 4.20, 4.21	either Working scientifically or Communicating scientifically
Knowledge and understanding	4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	Knowing and understanding
PFA	4.1, 4.2, 4.3, 4.4, 4.5	Knowing and understanding

The use of SOLO in the ESSA framework

SOLO, which stands for the structure of observed learning outcome, provides a systematic way of describing how a learner's performance grows in complexity when mastering learning tasks. SOLO is based on the use of working memory. It can be used to define curriculum outcomes, which describe where a student *should* be operating, and for evaluating learning outcomes so that we can know at what levels individual students actually *are* operating.

The SOLO model is based on the study of outcomes in a variety of academic content areas (Biggs and Collis, 1982). As students learn, the outcomes of their learning display similar stages of increasing structural complexity. SOLO measures the quality of a person's response.

SOLO taxonomy provides the theoretical underpinning for the descriptions of student levels of achievement on the ESSA test.

References

John Biggs, 1999, *Teaching for quality learning at University*, SRHE and Open University Press, Buckingham, p37.

Biggs, J.B. and Collis, K.F. (1982) *Evaluating the quality of learning: the SOLO Taxonomy*. 1st edn, New York: Academic Press.

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