Marine Science

Senior Syllabus 2013

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Marine Science Senior Syllabus 2013

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1 Rationale

Marine science is concerned with researching marine environments to determine their biological and oceanographic features, and devising conservation strategies that may lead to a sustainable future. Marine environments are central to the Australian way of life, contributing to our nation's food supply, mineral resources and trade, and to the recreation, tourism and transport industries. Global population increases and changes in climate have the potential to impact on the fragility of marine environments, leading to a range of issues and problems that must be considered to ensure a sustainable future.

Marine Science enables inquiry-based learning, whereby students investigate marine environments, issues and problems in authentic and relevant contexts. Learning in context enables integration of the marine science concepts, systems and models of the four areas of study: marine biology, oceanography, conservation and sustainability, and marine research skills. Students develop holistic understandings of marine issues and problems as they actively explore marine environments. Investigating marine environments, issues and problems encourages students to become informed and active stewards of the marine environment.

Students plan and conduct practical and research-based marine investigations to explore marine environments, issues and problems. Owing to the nature of marine environments, students may develop the marine research skills of boating and snorkelling to access the environments under study. Students analyse, interpret and evaluate marine information to draw and justify conclusions, and make and justify decisions and recommendations. Decisions and recommendations relating to marine environments, issues and problems should encompass conservation strategies to ensure the sustainability of marine environments.

A course of study in Marine Science can establish a basis for further education and employment in the fields of marine science, marine biology, nautical science, fisheries and aquaculture, conservation and resource management, and tourism, seafood and maritime industries.

2 Dimensions and objectives

The dimensions are the salient properties or characteristics of distinctive learning for this subject. The dimensions are described through their objectives and it is these that schools are required to teach and that students should have the opportunity to learn. The objectives describe what students should know and be able to do by the end of the course of study.

Progress in a particular dimension may depend on the qualities and skills developed in other dimensions. Learning through each of the dimensions must increase in complexity to allow for greater independence of the learner over a four-semester course of study.

Schools must assess how well students have achieved the objectives. The standards have a direct relationship with the objectives, and are described in the same dimensions as the objectives.

The dimensions for a course of study in this subject are:

- Dimension 1: *Knowledge and understanding*
- Dimension 2: *Investigation and analysis*
- Dimension 3: *Evaluation and communication.*

2.1 Dimension 1: *Knowledge and understanding*

The dimension *Knowledge and understanding* involves students defining and describing marine science concepts, explaining marine systems using concepts and models, and applying understandings to marine environments, issues and problems.

2.1.1 Objectives

By the conclusion of the course of study, students should:

- define and describe marine science concepts
- explain marine systems using concepts and models
- apply understandings to marine environments, issues and problems.

When students define and describe marine science concepts, they state the meaning of these concepts and provide an account of their features. Marine science concepts are the basic or fundamental ideas that underpin this subject, including those that underpin the marine research skills of boating and snorkelling.

When students explain marine systems, they use concepts and models to demonstrate their understanding of the interrelationships that exist within these systems.

When students apply understandings, they use their knowledge of marine science concepts, models and systems to identify and explain issues and problems relevant to marine environments. Marine issues are current and relevant topics that cause concern and are open to discussion or debate. Marine problems are questions posed for possible solutions.

Knowledge and understanding of marine science concepts, models and systems underpins the Investigation and analysis of marine environments, issues and problems and the Evaluation and communication of marine information.

2.2 Dimension 2: *Investigation and analysis*

The dimension *Investigation and analysis* involves students planning inquiry-based investigations, collecting, selecting and organising marine information, and analysing and interpreting information to identify and explain relationships, trends and patterns.

2.2.1 Objectives

By the conclusion of the course of study, students should:

- formulate questions, hypotheses and plans for marine investigations
- collect primary data using marine research skills
- select and organise marine information from primary and secondary sources
- analyse and interpret marine information to identify and explain relationships, trends and patterns.

When students formulate questions, hypotheses and plans, they devise or construct these to guide marine investigations, both practical and research-based. Plans include methods, procedures, techniques or a progression of stages employed to accomplish a set goal.

When students collect primary data, they may use marine research skills to gather this data (e.g. boating, snorkelling, field techniques).

When students select and organise marine information from primary and secondary sources, they determine the relevant knowledge and data and sequence it to achieve a purpose. Students may consider accuracy and reliability to determine the validity of secondary sources.

When students analyse marine information, they identify relationships, trends and patterns. This may involve identifying errors and anomalies. Students may use specific data points to support analyses. When students interpret marine information, they explain the relationships, trends and patterns identified through analysis.

2.3 Dimension 3: *Evaluation and communication*

The dimension *Evaluation and communication* involves students examining and judging marine information to draw and justify conclusions, and make and justify decisions and recommendations. Students communicate their findings to audiences for a particular purpose.

2.3.1 Objectives

By the conclusion of the course of study, students should:

- evaluate marine information to draw conclusions, and make decisions and recommendations
- justify conclusions, decisions and recommendations about marine environments, issues and problems
- communicate using language conventions to suit audiences and purposes.

When students evaluate, they make judgments to draw conclusions, and make decisions and recommendations based on the analysis and interpretation of marine information. Students consider a range of alternatives before making decisions and they look to the future when making recommendations, including modifications to equipment and procedures.

When students justify conclusions, decisions and recommendations about marine environments, issues and problems, they provide evidence or reasoning to support their findings.

When students communicate, they select language conventions (spelling, punctuation, grammar, genre, referencing) to convey marine information to audiences in order to achieve a purpose.

3 Course organisation

3.1 Course overview

The minimum number of hours of timetabled school time, including assessment, for a course of study developed from this syllabus is 55 hours per semester. A course of study will usually be completed over four semesters (220 hours).

This syllabus is designed to enable schools to develop a course relevant to both local and global marine environments, issues and problems.

A four-semester course of study includes:

- four to eight units of work
- four areas of study, each with three key concepts and associated elaborations (see Section 3.1.1)
- inquiry-based investigations of marine environments, issues and problems (see Section 3.1.2)
- three organising principles (see Section 3.1.4).

3.1.1 Areas of study

In Marine Science, there are four areas of study:

- marine biology
- oceanography
- conservation and sustainability
- marine research skills.

Each area of study consists of three key concepts and associated elaborations (see Figure 1 on page 5).

The three key concepts of each area of study are core to Marine Science.

The three key concepts of each area of study are covered once in Year 11 and once in Year 12, prior to verification. The development of key concepts over the course of study should reflect the three organising principles (see Section 3.1.4).

At least two areas of study should be evident in each unit of work. Integrating areas of study leads to a holistic understanding of marine environments.

When developing an inquiry-based unit of work, key concepts and elaborations from relevant areas of study are selected and developed to suit the inquiry (see Section 3.1.2).

Figure 1: Marine Science areas of study

Areas of study	Key concepts		Elaborations
Marine biology (MB)	**MB1**	Marine environments support an abundance of diverse life, which is classified according to a range of characteristics.	MB1.1–1.6
	MB2	Marine organisms are shaped by their environments and interactions.	MB2.1–2.6
	MB3	The marine environment consists of dynamic and complex relationships between organisms and ecosystems.	MB3.1–3.6
Oceanography (OC)	**OC1**	The world's oceans and coastlines have many unique geological features.	OC1.1–1.6
	OC2	The world's oceans are involved in the dispersal and cycling of all matter.	OC2.1–2.6
	OC3	The world's oceans and global climate are inextricably linked.	OC3.1–3.6
Conservation and sustainability (CS)	**CS1**	Human activities can affect the marine environment in a variety of ways.	CS1.1–1.7
	CS2	Sustainable management practices are essential for the protection of marine resources.	CS2.1–2.7
	CS3	Gathering and interpreting scientific information is necessary to make informed decisions on sustainability.	CS3.1–3.6
Marine research skills (MS)	**MS1**	Safety is a primary concern in marine research skills.	MS1.1–1.6
	MS2	Boating, snorkelling and field techniques enable engagement with marine environments.	MS2.1–2.6
	MS3	Navigation and communication are essential tools for investigating marine environments.	MS3.1–3.6

Marine biology

Marine environments are home to a wide variety of marine organisms, each with unique characteristics that enable survival. Observation and classification of marine organisms allows populations to be monitored over time. Organisms and ecosystems form dynamic and complex relationships, which shape the adaptations of the organism and the features of ecosystems.

Table 1: Marine biology key concepts and associated elaborations

Area of study	**Marine biology (MB)** 					
Key concepts	**MB1**	**Marine environments support an abundance of diverse life, which is classified according to a range of characteristics.**	**MB2**	**Marine organisms are shaped by their environments and interactions.**	**MB3**	**The marine environment consists of dynamic and complex relationships between organisms and ecosystems.**
Elaborations	MB1.1	Biodiversity, the variety and abundance of life, is an indication of the health of marine environments.	MB2.1	The interactions of marine organisms with abiotic factors of habitats impact on adaptations (e.g. dissolved oxygen, salinity, substrate).	MB3.1	Ecology is the study of abiotic and biotic factors which are observed through field study techniques (e.g. transects, trawls).
	MB1.2	There are a number of different classification systems for marine organisms according to a range of characteristics (e.g. benthic layer, mode of locomotion, coral shape, trophic level, life cycle).	MB2.2	The interactions of marine organisms with biotic factors of habitats impact on adaptations (e.g. competition for food and space, predator–prey).	MB3.2	Marine organisms live in a variety of habitats, which may be classified according to biotic and abiotic factors (e.g. rocky shore, pelagic zone, bioregion).
	MB1.3	Classification or taxonomy provides a framework for the naming and identification of organisms that is recognised by all scientists (e.g. Linnaean binomial naming system).	MB2.3	Adaptations arise through genetic mutations of DNA which produce characteristics favourable to a particular environment.	MB3.3	Organisms in food webs interact via relationships and consumer levels as energy cycles through food webs (e.g. primary producers, consumers).
	MB1.4	Organisms are classified according to levels (e.g. kingdom, phylum, class, order, family, genus and species).	MB2.4	Adaptations are classified as anatomical (structural), physiological (functional) or behavioural.	MB3.4	Marine organisms interact and populate habitats in various ways throughout the stages of their life cycle.
	MB1.5	The different phyla of Kingdom Plantae and Animalia contain distinct anatomical and physiological structures, which are observed through dissection.	MB2.5	Studies of the evolutionary history of organisms reveal adaptations that occur in response to habitat changes.	MB3.5	Marine and freshwater ecosystems interact through estuaries, with species adapting to environmental conditions (e.g. mangroves).
	MB1.6	Field guides and identification keys use scientific and common names to classify organisms according to distinct and observable features.	MB2.6	Introduced and migrating species have the potential to alter marine environments and the adaptations of native species (e.g. European fan worm, northern Pacific sea star, Caulerpa taxifolia).	MB3.6	Organisms populate areas following changes in habitats and environments (e.g. succession).

Oceanography

The movement of water, atmospheric gases, nutrients, heat and pollution shapes oceans, coastlines and global climate. Studying the geological features of oceans enhances our understanding of the cycling of matter and provides a link to the distribution of marine species. Developing awareness of the role of human activities in shaping oceans, coastlines and climates can inform sustainable resource management decisions.

Table 2: Oceanography key concepts and associated elaborations

Area of study	**Oceanography (OC)**					
Key concepts	**OC1**	**The world's oceans and coastlines have many unique geological features.**	**OC2**	**The world's oceans are involved in the dispersal and cycling of all matter.**	**OC3**	**The world's oceans and global climate are inextricably linked.**
Elaborations	OC1.1	Tectonic plate movements due to convection currents in magma lead to change, including continental drift and sea floor changes and natural disasters (e.g. earthquakes, volcanoes, tsunamis).	OC2.1	Water, atmospheric gases, nutrients, heat and pollution are cycled between oceans, the land and the atmosphere and are represented using models.	OC3.1	The relationship between the atmosphere and the oceans drive weather patterns and climate (e.g. temperature, wind speed and direction, rainfall, breezes, barometric pressure).
	OC1.2	The ocean floor has many features including the continental margin, ocean-basin floor, deep-sea trenches and mid-ocean ridges which are mapped using survey technologies (e.g. echo sounding).	OC2.2	Surface ocean currents are driven by wind and gravity, distributing water, heat and nutrients across coastal regions and global ocean basins (e.g. upwellings and downwellings, El Niño and La Niña events, Langmuir circulation, Ekman Spiral).	OC3.2	Wave properties are shaped by weather patterns, natural formations and artificial structures (e.g. interference patterns, fetch, wave sets).
	OC1.3	Developing models assist in understanding the geological features of the earth (e.g. sea floor modelling, tectonic plate movements, coastal landforms).	OC2.3	Seawater contains over 80 chemical elements which determine physical and chemical properties of the oceans (e.g. salinity, heat capacity, density).	OC3.3	Natural global processes and human activity lead to environmental and climatic change (e.g. increased concentrations of carbon dioxide in the atmosphere, increased temperatures).
	OC1.4	Marine environments consist of zones, classified according to features such as availability of light and substrate composition (e.g. intertidal zone, continental margin, abyssal plane, oceanic trenches and mid-ocean ridges).	OC2.4	Thermohaline circulation in the deep ocean is affected by salinity, water density and temperature, influencing the productivity of different regions.	OC3.4	Increases in average global temperatures impact on marine environments by altering thermal regimes and changing physical and chemical parameters of the ocean (e.g. rising sea levels and ocean acidification).
	OC1.5	Coastlines are shaped by a number of factors including tectonic plate movements, weather patterns, and movement of sediments and water (e.g. waves, currents).	OC2.5	Tidal movement is driven by the gravitational pull of both the moon and sun, influencing current strength, wave action, distribution and activity in the ocean (e.g. sediment, species).	OC3.5	Ocean acidification and increased ocean temperatures have the potential to alter the primary productivity of the ocean.
	OC1.6	Maritime jurisdictional zones are linked to sea floor topography and are used in natural resource management.	OC2.6	Wave action, wind and longshore drift are factors to consider in the management of the movement of water, nutrients, sand and pollutants (e.g. oil spills).	OC3.6	Reducing the effects of climate change is a complex issue requiring global agreements, national frameworks, industry participation, community decisions and individual action.

Conservation and sustainability

Humans have a long-held affinity with the ocean. In order to ensure longevity of marine environments, human activities must be monitored. Gathering and interpreting data from marine environments can determine the effects of human activities and guide sustainable resource management decisions.

Table 3: Conservation and sustainability key concepts and associated elaborations

Area of study	**Conservation and sustainability (CS)**					
Key concepts	**CS1**	**Human activities can affect the marine environment in a variety of ways.**	**CS2**	**Sustainable management practices are essential for the protection of marine resources.**	**CS3**	**Gathering and interpreting scientific information is necessary to make informed decisions on sustainability.**
Elaborations	CS1.1	For many cultural groups, marine environments are central to meeting nutritional, recreational and ceremonial needs (e.g. Aboriginal and Torres Strait Islander peoples, international communities).	CS2.1	Sustainable management practices, economic and ecological, are shaped by the environmental philosophies of stakeholders (e.g. local communities, Aboriginal and Torres Strait Islander peoples).	CS3.1	Knowledge of the oceans is limited and requires further investigation.
	CS1.2	The economic development of a nation and the value placed on marine environments affects decisions relating to resource management.	CS2.2	The Exclusive Economic Zone is internationally recognised by the United Nations with each nation being responsible for resource management.	CS3.2	Methods and devices are used to collect data relating to water quality and population density and distribution (e.g. transect, quadrat, zonation studies).
	CS1.3	The marine tourism industry is important to Australia's economy and has potential impacts on marine health, water quality and biodiversity (e.g. habitat destruction, pollution, overuse).	CS2.3	Recreational and commercial use of marine environments is managed through zoning, legislation, licensing and enforcement to protect the longevity of marine ecosystems.	CS3.3	Longitudinal studies allow scientists to observe changes occurring in marine environments (e.g. satellite imagery, aerial photography, field research).
	CS1.4	Aquaculture and recreational and commercial fishing place demands on marine ecosystems which must be monitored to ensure sustainable futures (e.g. overfishing, ocean ranching).	CS2.4	Increases in population density of coastal areas impact on the health of coastal water and should be carefully managed for sustainable outcomes (e.g. loss of mangroves, saltmarshes and seagrasses).	CS3.4	Research into the effects of human activities and resource management practices should be conducted to evaluate long-term impacts.
	CS1.5	The location of commercial industries affect marine environments due to outputs (e.g. chemical toxicants, nutrients, sediments and petrochemicals).	CS2.5	Land management practices contribute to the health of marine ecosystems (e.g. siltation, algal blooms, agricultural practices).	CS3.5	Marine scientists work in a variety of fields that contribute to the sustainability of marine environments (e.g. research, education, policies).
	CS1.6	Legislation aims to reduce the inappropriate utilisation of environments (e.g. Environmental Protection Act 1994, Marine Parks [Moreton Bay] Zoning Plan 2008).	CS2.6	Education of stakeholders is essential to encouraging sustainable management practices (e.g. consumers, recreational and commercial fishers).	CS3.6	Decision making involves the consideration of a range of stakeholders' views and a range of alternative pathways for action.
	CS1.7	Coastal engineering, including structures built to regulate water or sediment flow, affect currents and marine ecosystems (e.g. rock walls, canal estates).	CS2.7	Consultation through stakeholder groups guides policies relating to sustainable marine practices (e.g. Local Marine Advisory Committees [LMACs], CoralWatch, Australian Marine Environment Protection Association [AUSMEPA]).		

Marine research skills

Marine research skills enable students to access marine environments to gather data and undertake investigations. The *nature* and *extent* to which a school develops marine research skills depends on factors such as location, resourcing, teacher qualifications and time. Schools wishing to provide opportunities for students to build further snorkelling and boating skills must be satisfied that students are competent before entering marine environments. Schools must ensure the dimensions of this syllabus are met — complementary licences and certificates are additional.

Table 4: Marine research skills key concepts and associated elaborations

Area of study	**Marine research skills (MS)** 					
Key concepts	**MS1**	**Safety is a primary concern in marine research skills.**	**MS2**	**Boating, snorkelling and field techniques enable engagement with marine environments.**	**MS3**	**Navigation and communication are essential tools for investigating marine environments.**
Elaborations	MS1.1	Regulatory requirements and procedures are essential for dealing with hazards, accidents and emergencies (e.g. collision regulations, safety obligations, zoning).	MS2.1	Vessels, instruments and techniques are used to observe and record the abiotic and biotic features of marine environments.	MS3.1	Marine navigation and communication devices (e.g. GPS [global positioning system], radio, mobile phone) and procedures are used for coordination and safety (e.g. EPIRB).
	MS1.2	Risk assessments are carried out before conducting investigations in the laboratory and the field (e.g. sun protection, chemical material safety data sheets [MSDS], participant ability).	MS2.2	Operating a vessel safely in different conditions (e.g. anchoring, rope work, motors, sails) and maintaining and servicing boat parts and accessories is a component of marine research.	MS3.2	Chart datum and the IALA-A (International Association of Lighthouse Authorities region A) buoyage system are interpreted when operating vessels in marine environments.
	MS1.3	Water safety skills (e.g. survival and rescue techniques) and first aid procedures (e.g. basic first aid skills and resuscitation) are important when undertaking marine activities.	MS2.3	Boat design, including hulls, materials and methods of propulsion, should suit the area and purpose of operation.	MS3.3	Navigational aids, including compass, GPS, radar and charts are used to plot courses and record locations (e.g. latitude/longitude, position-fixing methods) as navigational precision is required for establishing and revisiting research sites.
	MS1.4	Dangerous marine organisms are identified and administration of first aid treatment is conveyed.	MS2.4	Snorkelling equipment and practices are used to observe or survey underwater ecosystems, including conducting transect studies.	MS3.4	A safe passage is planned and implemented using a variety of calculations and modifications (e.g. speed, distance, time).
	MS1.5	Weather forecasts and synoptic charts are interpreted prior to and during investigations with decisions being made according to changing weather conditions.	MS2.5	Underwater physics and physiology influence underwater activities (e.g. Boyle's law) and are an important consideration when snorkelling.	MS3.5	Radio transmission communication should be clear and concise (e.g. vessel identification, logging vessel movement, etiquette) and fitting to local regulatory requirements.
	MS1.6	Safety equipment relevant to marine activities (e.g. PFD [personal flotation device], EPIRB [emergency position-indicating radio beacon]) and laboratories (e.g. eyewash, fire-fighting equipment) is used and maintained.	MS2.6	Abiotic and biotic factors are examined in the field and the laboratory using specialised equipment (e.g. secchi disc, dissolved oxygen meter, dissection kits).	MS3.6	Organisations play vital roles in search and rescue operations (e.g. Australian Maritime Safety Authority's role in Safety of Life at Sea).

3.1.2 Inquiry-based learning

Marine Science enables inquiry-based learning through which students conduct primary and/or secondary research into marine environments, issues and problems.

Inquiry-based learning is a process and a way of thinking when investigating marine environments, issues and problems (see Figure 2 on page 11). It is an effective strategy for:

- developing higher order thinking skills in Marine Science, including analysing, interpreting, evaluating and justifying
- increasing student involvement and ownership of the investigation of marine environments, issues and problems
- embedding effective teaching and learning principles in Marine Science
- recognising and catering for difference, in both school location and student interests.

The guiding principles for inquiry-based learning are:

- effective inquiry is a skill that requires explicit teaching
- inquiry-based learning is not a linear process as Figure 2 attempts to illustrate
  - students often revisit stages of the inquiry-based investigation following periods of reflection and critical thinking
  - attending to one stage in the process may prompt students to return to a previous stage (e.g. inquiry-based investigations may give rise to further research questions)
- inquiry occurs within a context for learning that is authentic and relevant.

Developing contexts for inquiry-based investigations

Inquiry-based investigations provide students with opportunities to learn in circumstances that are relevant and interesting to them. Inquiry-based learning is used to bring the areas of study together in contexts.

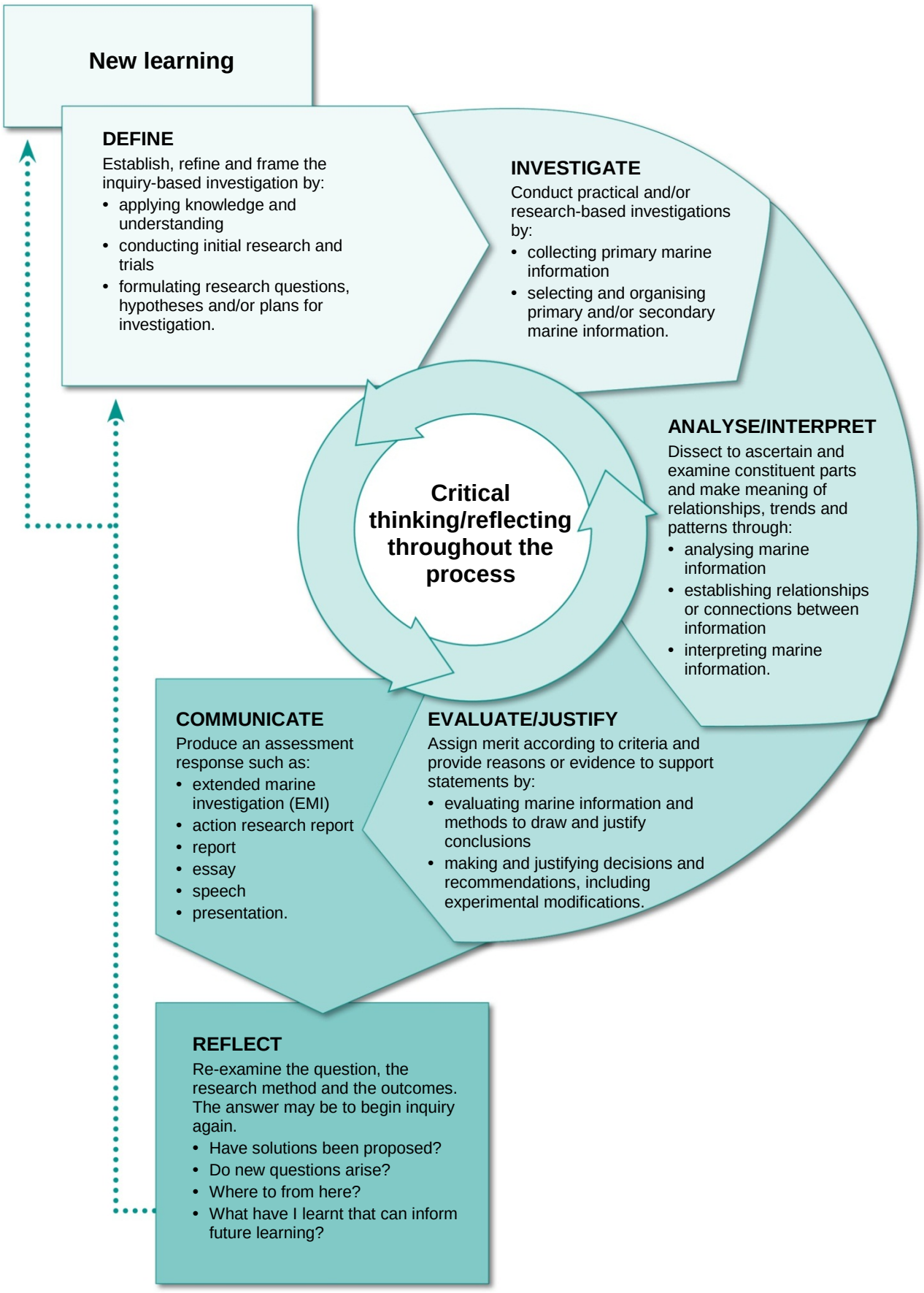
Contexts for inquiry in Marine Science should be based on the investigation of marine environments, issues or problems.

Examples include:

- local and global marine issues (e.g. human activity, climate change, pollution)
- local and global marine environments (e.g. Great Barrier Reef, Moreton Bay, international marine protected areas)
- local marine area field studies (e.g. local rivers, estuaries, rocky shores islands)
- the use of marine technologies (e.g. surveillance, research and monitoring technologies)
- marine industries (e.g. tourism, fishing)
- marine problems (e.g. designing boat hulls for a purpose).

The selection of key concepts and elaborations should be based on the context for learning. Further resources to support the development of inquiry are available on the Marine Science subject page at <www.qsa.qld.edu.au/20319.html>.

Figure 2: Inquiry-based learning in Marine Science

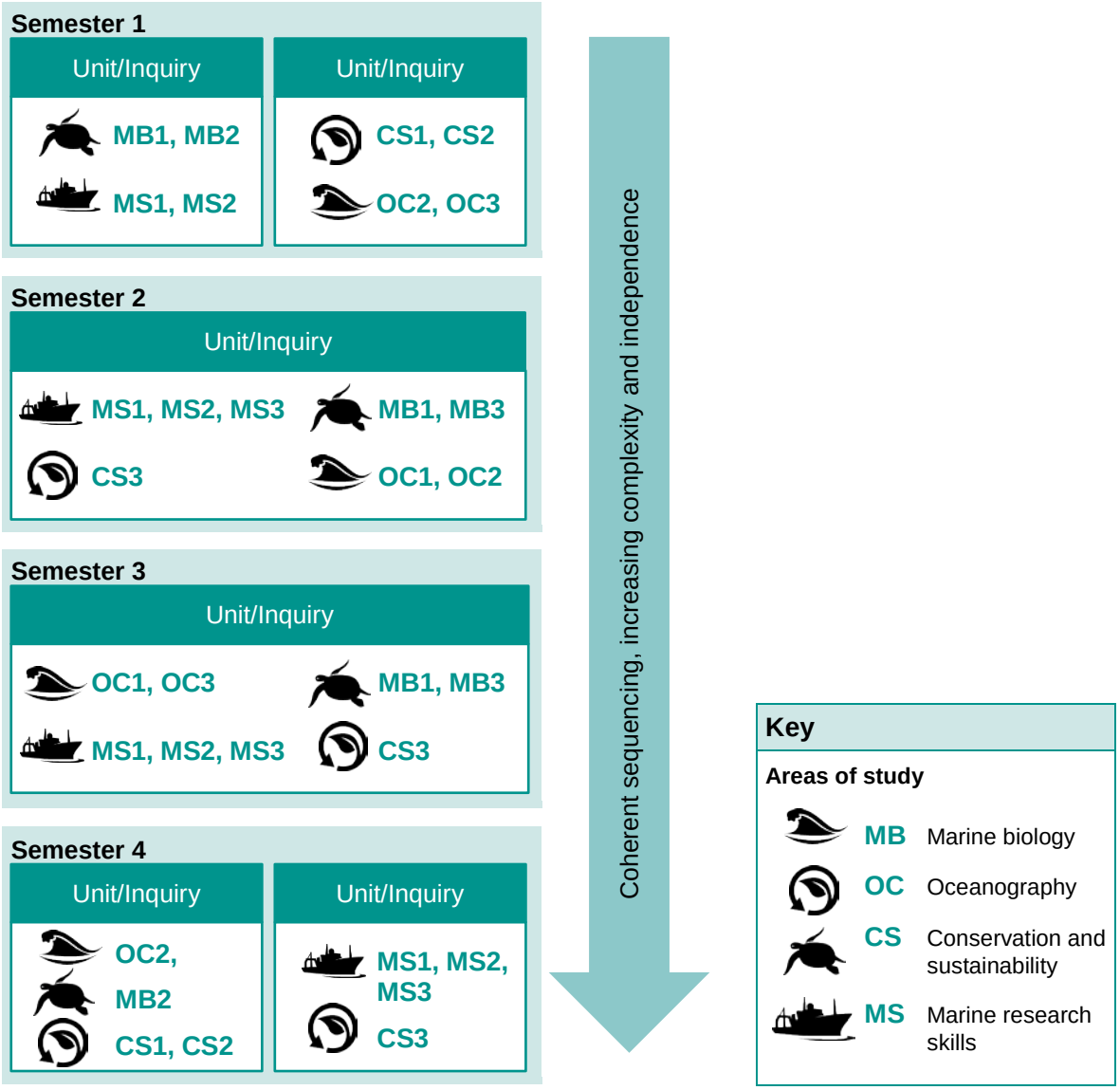


3.1.3 Planning a course of study

A four-semester course of study in Marine Science (see Figure 3) includes:

- four to eight units of work, ranging from 20 to 55 hours
- an integration of the four areas of study: marine biology, oceanography, conservation and sustainability, and marine research skills (see Section 3.1.1)
- evidence of key concepts being covered at least twice before verification, once in Year 11 and once in Year 12 (see Figure 1 on page 5)
- at least one inquiry-based investigation of a marine environment, issue or problem per year (see Section 3.1.2)
- consideration of the organising principles: coherent sequencing, increasing complexity and increasing independence (see Section 3.1.4)
- safe access to and use of marine resources.

Figure 3: Planning a course of study



Developing units of work

Four to eight units of work should be developed around:

- at least two areas of study (see Section 3.1.1)
- key concepts and elaborations from the relevant areas of study.

Where possible, schools are encouraged to develop inquiry-based investigations of marine environments, issues and problems (see Section 3.1.2).

3.1.4 Organising principles

There are three organising principles that underpin a course of study in Marine Science:

- coherent sequencing
- increasing complexity
- increasing independence.

Coherent sequencing

To ensure coherent sequencing, the key concepts and elaborations should be mapped across the four-semester course of study. Marine science concepts are taught in a sequential order, with fundamental concepts being introduced before more advanced concepts.

Key concepts need to be explored in at least two different units of work, once in Year 11 and once in Year 12. Revisiting key concepts allows for greater depth as further elaborations may be covered and/or different combinations of elaborations brought together.

Increasing complexity

It is expected that the degree of complexity will increase over the course of study. The increasing complexity will be reflected in the teaching and learning experiences, and the assessment program developed by the school. Complexity can vary according to depth and scope.

Depth refers to the development of understandings from simple through to complex, within and across the key concepts. This may involve the coverage of fewer elaborations as concepts are explored in greater depth. Scope refers to the coverage of a number of key concepts and elaborations in each unit of work. The integration of elaborations and areas of study enables students to make connections between and across areas of study.

Increasing independence

Independence increases as students are required to accept responsibility for their own learning across the course. Students plan and conduct a range of investigations, evaluating research methods, skill development and assessment responses to identify ways to improve.

Learning experiences and assessment instruments must reflect students' progression through the stages of the course.

Early in the course, students:	**Increasingly independent students:**
• conduct a broad examination of marine environments, issues and problems	• conduct an in-depth study of specific marine environments, issues and problems, some of which may be identified by students
• undertake a directed study of a local ecosystem, considering a narrow range of variables	• undertake an independent study/comparison of ecosystems, showing interconnections between terrestrial and marine ecosystems, and/or a range of variables
• conduct group, assisted and modelled extended marine investigations (EMIs) or action research.	• conduct independent EMIs or action research with multiple variables (where possible) and reduced teacher input.

3.2 Further considerations

Owing to the practical nature of Marine Science, important factors relating to resourcing must be considered when planning a course of study. References to external agencies are supported by the Reference list located on the Marine Science subject page of the QSA website <www.qsa.qld.edu.au/20319.html>.

3.2.1 Marine resources

Schools should develop units of work that are compatible with available resources. In order to ensure equity, all students should be provided with equal access to resources. To extend the range of learning experiences and assessment opportunities, schools should consider accessing outside providers and sharing resources within regional areas. Schools may consider accessing registered training organisations for the development of some marine research skills. Networks for sharing resources may be established through the Marine Teachers Association of Queensland (MTAQ) <www.marineteachers.org.au>.

3.2.2 Field studies and marine research skill development

Field studies and marine research skill development are integral to Marine Science. It is strongly recommended that these skills be developed across the course of study to allow students opportunities to access the objectives of the dimensions, and to enhance student learning.

It is important that schools provide adequate time for activities of this nature. A minimum of 18 hours per school year must be allowed for student field studies and marine research skill development in marine environments. Field studies and marine research skill development may range from local, short-duration activities to an extended excursion.

Schools must be satisfied that students have sufficient competency in boating and snorkelling before conducting investigations in marine environments. Where licences and certificates are offered to complement the school's assessment program, schools must ensure sufficient time is allocated to develop the syllabus objectives and the standards used to assess each dimension.

Field studies and marine research skill development must be integrated with the areas of study to help students develop a better understanding of marine environments. The site chosen and the key concepts developed may determine the field studies and marine research skills selected for development.

3.2.3 Workplace health and safety

Marine Science is designed to give students exposure to the practical components of working, studying and living in marine environments through practical experiences in the laboratory and the field. These experiences expose students to a variety of hazards, from biological and poisonous substances to physical injury. Besides a teacher's duty of care that derives from the *Education (General Provisions) Act 2006*, there are other legislative and regulatory requirements, for example the *Work Health and Safety Act 2011*, which influence the nature and extent of practical work.

All practical work must be organised with student safety in mind. In Marine Science, there are many activities associated with handling biological materials and developing marine research skills that may expose teachers and students to safety hazards.

The current science safety requirements are clearly explained in the Curriculum Activity Risk Assessment Guidelines: Marine Science (CARAs) located on the Queensland Government's Department of Education, Training and Employment (DETE) website. The CARAs pertaining to Marine Science activities are developed to meet legislative requirements. Risk assessment documents are in the DETE Policy and Procedure Register.

It is the responsibility of all schools to ensure that their practices meet current legislation requirements.

3.2.4 Teacher qualifications

As students conduct research and field studies in marine environments which may require developing marine research skills (e.g. snorkelling, boating), it may benefit teachers of Marine Science to develop skills and gain qualifications in these areas. The Department of Education and Training Curriculum Activity Risk Assessment Guidelines (CARAs) outline the minimum qualifications required to lead activities in marine environments. The CARAs stipulate the minimum qualifications required for activity leaders. Where a school appoints a qualified activity leader, the operation of that activity remains the responsibility of the school. It is the school's responsibility to check the qualifications and equipment of those who are entrusted as activity leaders. It is also important to note that the ultimate responsibility for student supervision cannot be fully delegated to activity leaders, as teachers are required to be present.

Relevant legislation and regulations must be considered when devising educational experiences. By observing all appropriate legislation and regulations, schools will be able to deliver educational experiences that meet syllabus requirements and fulfil their duty of care in the safest possible manner. The Department of Education and Training Curriculum Activity Risk Assessment Guidelines (CARAs) are written to meet legislative requirements.

Possible teacher qualifications

Teachers of Marine Science may benefit from obtaining the following qualifications:

- Apply First Aid (HLTFA301B)
- Cardiopulmonary Resuscitation (HLTCPR201A)
- Surf Life Saving Bronze Medallion (Surf Life Saving Queensland)
- Recreational Marine Driver's Licence (Maritime Safety Queensland)
- Teacher's Restricted Coxswain Licence (Maritime Safety Queensland)
- Snorkel Guide Certification (various registered training organisations).

Teacher exception from full coxswain

The leader of a commercially registered power vessel in Queensland waters is required to hold a Restricted Coxswain Licence as a minimum qualification.

Under an agreement between the MTAQ and Maritime Safety Queensland (MSQ), school or college employees may be issued a Restricted Coxswain (Schools) Licence endorsed for implementing a QSA approved or accredited syllabus in sheltered waters anywhere in Queensland. This licence can be obtained upon application supported by a declaration by the Principal that the person meets the mandatory requirements (and payment of the appropriate fee). Applications for and alterations to endorsements for licences should be made to MSQ through the nearest Regional Harbour Master's Office.

One of the requirements of the Restricted Coxswain (Schools) Licence is the demonstrated ability to operate within the requirements of the Department of Education, Training and Employment Procedure HLS-PR-012: Workplace Health and Safety — Curriculum Delivery and the Schedule of Risk Management for Power Boating in Small Craft.

Notwithstanding any other legislation, regulations or policies, the ultimate consideration for teachers is the duty of care that derives from their employment. Subject-specific guidelines about legislation and regulations relevant to delivering educational experiences are available on the Marine Science subject page at <www.qsa.qld.edu.au/20319.html>.

Further details relating to teacher qualifications and safety requirements are available on the MTAQ website <www.marineteachers.org.au>.

Requirements for vessels

In accordance with the Transport Operations (Marine Safety) legislation, a vessel used for commercial purposes must be registered as a commercial vessel. Schools are considered as commercial enterprises and are not exempted under the legislation; however there is provision in the regulations for ships used as training ships.

Typically, schools use Class 2E, 2D or 2C commercial ships. The safety requirements for these vessels are based in the Transport Operations (Marine Safety — Commercial Ships and Fishing Ships Miscellaneous Equipment) Standard 2006. This standard and the Transport Operations (Marine Safety) Regulation 2004 are located on the MSQ website.

From 2013, the Australian Maritime Safety Authority (AMSA) will implement federal domestic commercial vessel laws. This national system will have an impact on the way schools in Queensland register boats and deliver boating learning experiences. It is the responsibility of schools to meet the requirements of state and federal legislation. Further details relating to the national requirements are available on the AMSA website <www.amsa.gov.au>. For more information relating to the teaching of boating in Queensland, schools should visit the MTAQ website <www.marineteachers.org.au>.

3.2.5 Animal welfare and ethics

The *Animal Care and Protection Act 2001* (the Act) and the accompanying Animal Care and Protection Regulation 2002 govern the treatment and use of all animals in Queensland. The Department of Agriculture, Fisheries and Forestry Queensland (DAFF), through Biosecurity Queensland, is responsible for enforcement of the legislation.

The purpose of the Act is to promote the responsible care and use of animals, provide standards for the care and use of animals, protect animals from unjustifiable, unnecessary or unreasonable pain, and ensure that the use of animals for scientific purposes is accountable, open and responsible.

“Scientific purposes” is defined as any activity performed to acquire, demonstrate or develop knowledge or a technique in a scientific discipline including teaching. Under the Act an animal is any live vertebrate or cephalopod. This includes amphibians, birds, fish, mammals (other than humans), reptiles and cephalopods (octopus, squid, cuttlefish and nautilus). This also includes live prenatal or prehatched creatures in the last half of gestation, including mammalian or reptilian foetus, prehatched avian, mammalian or reptilian young (eggs), and live marsupial young. It does not include invertebrates other than cephalopods; the eggs, spat or spawn of fish; and immature amphibians and fish that have not reached final metamorphosis. Further details of the categories covered by the Act can be obtained from DAFF.

The Act also requires mandatory compliance with the *Australian code of practice for the care and use of animals for scientific purposes 7th edition 2004* (the Code), available from the National Health and Medical Research Council’s publications website.

The Code provides guidance for institutions, researchers, teachers and animal ethics committees on the ethical framework necessary to ensure that the welfare of animals used for research and teaching is given an appropriate level of consideration. National codes of practice are available for most livestock industries, and outline acceptable standards of husbandry and management. There are also Model Codes of Practice available from the DAFF website that cover areas such as transporting livestock, saleyards and abattoirs.

In Queensland, the national livestock codes are used as the minimum standard. Codes of Practice are available from the CSIRO publishing website.

In order to comply with the Act, teachers or employing institutions intending to use animals for scientific purposes (which include teaching) must:

- register with the DAFF and nominate the Animal Ethics Committee (AEC) that will assess the animal use activity

- ensure the animal use activity is approved by the AEC before commencing the activity
- comply with the annual reporting requirements of the AEC and the DAFF for all approved activities in which animals were used.

Animals must not be used for scientific purposes in any Queensland school without prior written approval from the Queensland Schools Animal Ethics Committee (QSAEC).

The QSAEC is a cross-sector committee linking Education Queensland, Queensland Catholic Education Commission and Independent Schools Queensland, and includes members drawn from the scientific and wider community to bring a diversity of knowledge, values and beliefs to the committee. The QSAEC meets once a term, usually during the third week of each term. There are at least four meetings of the QSAEC each year.

The main task of the members of the QSAEC is to assess and monitor animal use in schools to safeguard the welfare of the animals involved. The QSAEC members decide whether proposed activities using animals are justified, that the "3Rs" (replacement, refinement and reduction) have been considered and that the welfare needs of the animals have been adequately met.

References to external agencies are supported by the Reference list located on the Marine Science subject page of the QSA website <www.qsa.qld.edu.au/20319.html>.

3.3 Advice, guidelines and resources

3.3.1 Aboriginal and Torres Strait Islander perspectives

The Queensland Government has a vision that Aboriginal and Torres Strait Islander Queenslanders have their cultures affirmed, heritage sustained and the same prospects for health, prosperity and quality of life as other Queenslanders. The QSA is committed to helping achieve this vision and encourages teachers to include Aboriginal and Torres Strait Islander perspectives in the curriculum.

The Queensland Studies Authority (QSA) recognises Aboriginal and Torres Strait Islander peoples, their traditions, histories and experiences from before European settlement and colonisation through to the present time. To strengthen students' appreciation and understanding of the first peoples of the land, opportunities exist in the syllabus to encourage engagement with Aboriginal and Torres Strait Islander:

- frameworks of knowledge and ways of learning
- contexts in which Aboriginal and Torres Strait Islander peoples live
- contributions to Australian society and cultures.

Aboriginal and Torres Strait Islander peoples have a long-held affinity with the marine environment. Relying on marine ecosystems for food and resources, these peoples developed sustainable management practices that ensured the continual abundance of marine organisms. The resource management strategies of Aboriginal and Torres Strait Islander peoples should be considered. Where possible, courses should be developed in collaboration with local Aboriginal and Torres Strait Islander communities to ensure that the course has mutual benefits.

Subject-specific resources are available on the Marine Science subject page. In addition, guidelines about Aboriginal and Torres Strait Islander perspectives and resources for teaching are available on the QSA website <www.qsa.qld.edu.au/577.html>.

3.3.2 Composite classes

This syllabus enables teachers to develop a course of study that caters for a variety of ways to organise learning, such as combined Years 11 and 12 classes, combined campuses, or modes of delivery involving periods of student-managed study. This resource provides guidelines about composite classes.

3.3.3 Embedding educational equity in the course of study

Equity means fair treatment of all. In developing work programs from this syllabus, schools need to provide opportunities for all students to demonstrate what they know and what they can do. All students, therefore, should have equitable access to educational programs and human and material resources.

In addition to the subject-specific resources available on the Marine Science subject page, guidelines about educational equity and resources for devising an inclusive work program are available on the QSA website <www.qsa.qld.edu.au/10188.html>.

3.3.4 Language education in Marine Science

It is the responsibility of teachers to develop and monitor students' abilities to use the forms of language appropriate to their own subject areas. This involves providing opportunities for the development of students' abilities in:

- selection and sequencing of information required in various forms (such as reports, essays, interviews and seminar presentations)
- use of technical terms and their definitions
- use of correct grammar, spelling, punctuation and layout.

3.3.5 Learning experiences and sample resources

This resource provides guidelines for learning experiences and sample resources, which may include unit/s of work.

3.3.6 Mathematical concepts in Marine Science

It is the responsibility of teachers to develop and monitor students' abilities to use mathematical concepts appropriate to their own subject areas. This involves providing opportunities for the development of students' abilities to:

- comprehend basic concepts and terms underpinning the areas of number, space, probability and statistics, and measurement
- extract, convert or translate information given in numerical forms, or as diagrams, maps, graphs or tables
- calculate and apply procedures
- use skills or apply concepts from one problem or one subject to another.

3.3.7 Reference materials

This resource provides links to reference materials, text and reference books, websites, newspaper reports, periodicals, electronic media and learning technology, and organisations and community resources for the subject.

3.3.8 Work program requirements

A work program is the school's plan of how the course of study will be delivered and assessed, based on the school's interpretation of the syllabus. It allows for the special characteristics of the individual school and its students. Work program requirements are available on the Marine Science subject page of the QSA website <www.qsa.qld.edu.au/20319.html>. Instructions for online submission of work programs are available from <https://www.qsa.qld.edu.au/wponline/login.qsa>.

4 Assessment

Assessment is an integral part of the teaching and learning process. For Years 11 and 12 it is the purposeful, systematic and ongoing collection of information about student learning outlined in the senior syllabuses.

In Queensland, assessment is standards based. The standards for each subject are described in dimensions, which identify the valued features of the subject about which evidence of student learning is collected and assessed. The standards describe the characteristics of student work.

The major purposes of assessment in senior Authority subjects are to:

- promote, assist and improve learning
- inform programs of teaching and learning
- advise students about their own progress to help them achieve as well as they are able
- give information to parents, carers and teachers about the progress and achievements of individual students to help them achieve as well as they are able
- provide comparable levels of achievement in each Authority subject which may contribute credit towards a Queensland Certificate of Education
- provide base data for tertiary entrance purposes
- provide information about how well groups of students are achieving for school authorities and the State Minister responsible for Education.

4.1 Principles of exit assessment

All the principles of exit assessment must be used when planning an assessment program and must be applied when making decisions about exit levels of achievement.

A standards-based assessment program for the four-semester course of study requires application of the following interdependent principles:

- information is gathered through a process of continuous assessment, i.e. *continuous assessment*
- balance of assessment is a balance over the course of study and not necessarily a balance over a semester or between semesters, i.e. *balance*
- exit levels of achievement are devised from student achievement in all areas identified in the syllabus as being mandatory, i.e. *mandatory aspects of the syllabus*
- assessment of a student's achievement is in the significant aspects of the course of study identified in the syllabus and the school's work program, i.e. *significant aspects of the course of study*
- selective updating of a student's achievement is undertaken over the course of study, i.e. *selective updating*
- exit assessment is devised to provide the fullest and latest information on a student's achievement in the course of study, i.e. *fullest and latest information*.

4.1.1 Continuous assessment

Judgments about student achievement made at exit from a course of study must be based on an assessment program of continuous assessment.

Continuous assessment involves gathering information on student achievement using assessment instruments administered at suitable intervals over the developmental four-semester course of study.

In continuous assessment, all assessment instruments have a formative purpose — to improve teaching and student learning and achievement.

When students exit the course of study, teachers make a summative judgment about their levels of achievement in accordance with the standards matrix.

The process of continuous assessment provides the framework in which the other five principles of exit assessment operate: *balance*, *mandatory aspects of the syllabus*, *significant aspects of the course of study*, *selective updating*, and *fullest and latest information*.

4.1.2 Balance

Judgments about student achievement made at exit from a course of study must be based on a balance of assessments over the course of study.

Balance of assessment is a balance over the course of study and not a balance within a semester or between semesters.

Balance of assessment means judgments about students' achievements of the dimensions and objectives are made a number of times using a variety of assessment techniques and a range of assessment conditions over the developmental four-semester course of study.

See also Section 4.6, Verification folio requirements.

4.1.3 Mandatory aspects of the syllabus

Judgments about student achievement made at exit from a course of study must be based on mandatory aspects of the syllabus.

The *mandatory aspects* are:

- the dimensions *Knowledge and understanding*, *Investigation and analysis* and *Evaluation and communication*
- the four areas of study: marine biology, oceanography, conservation and sustainability, and marine research skills.

To ensure that the judgment of student achievement at exit from a four-semester course of study is based on the mandatory aspects, the exit standards for the dimensions stated in the standards matrix must be used (see Section 4.8.2, Awarding exit levels of achievement).

4.1.4 Significant aspects of the course of study

Judgments about student achievement made at exit from a course of study must be based on significant aspects of the course of study.

Significant aspects are those areas described in the school's work program that have been selected from the choices permitted by the syllabus to meet local needs.

The significant aspects must be consistent with the objectives of the syllabus and complement the developmental nature of learning in the course of study over four semesters.

4.1.5 Selective updating

Judgments about student achievement made at exit from a course of study must be selectively updated throughout the course of study.

Selective updating is related to the developmental nature of the course of study and works in conjunction with the principle of fullest and latest information.

As subject matter is treated at increasing levels of complexity, assessment information gathered at earlier stages of the course of study may no longer be representative of student achievement. Therefore, the information should be selectively and continually updated (and not averaged) to accurately represent student achievement.

Schools may apply the principle of selective updating to the whole subject group or to individual students.

Whole subject-group

A school develops an assessment program so that, in accordance with the developmental nature of the course of study, later assessment information based on the same groups of objectives replaces earlier assessment information.

Individual student

A school determines the assessment folio for verification or exit (post verification). The student's assessment folio must be representative of the student's achievements over the course of study. The assessment folio does not have to be the same for all students; however, the folio must conform to the syllabus requirements and the school's approved work program.

Selective updating must not involve students reworking and resubmitting previously graded responses to assessment instruments.

4.1.6 Fullest and latest information

Judgments about student achievement made at exit from a course of study must be based on the fullest and latest information available.

- *Fullest* refers to information about student achievement gathered across the range of objectives.
- *Latest* refers to information about student achievement gathered from the most recent period in which achievement of the objectives is assessed.

As the assessment program is developmental, fullest and latest information will most likely come from Year 12 for those students who complete four semesters of the course of study.

The fullest and latest assessment information on mandatory and significant aspects of the course of study is recorded on a student profile.

4.2 Planning an assessment program

To achieve the purposes of assessment listed at the beginning of this section, schools must consider the following when planning a standards-based assessment program:

- dimensions and objectives (see Section 2)
- course organisation (see Section 3)
- principles of exit assessment (see Section 4.1)
- variety in assessment techniques and conditions over the four-semester course of study (see Section 4.5)
- verification folio requirements, i.e. the range and mix of assessment instruments necessary to reach valid judgments of students' standards of achievement (see Section 4.6)
- post-verification assessment (see Section 4.6.1)
- exit standards (see Section 4.7).

In keeping with the principle of continuous assessment, students should have opportunities to become familiar with the assessment techniques that will be used to make summative judgments.

Further information can be found on the Marine Science subject page of the QSA website <www.qsa.qld.edu.au/20319.html>.

4.3 Special provisions

Guidance about the nature and appropriateness of special provisions for particular students are described in QSA's *Policy on Special Provisions for School-based Assessments in Authority and Authority-registered Subjects* (2009), <www.qsa.qld.edu.au/2132.html>.

This statement provides guidance on responsibilities, principles and strategies that schools may need to consider in their school settings. Reasonable adjustments to students with specific educational needs must be planned and negotiated as early as possible so that students can be provided with appropriate support in order to commence, participate and complete course of study requirements. The special provisions might involve alternative teaching approaches, assessment plans and learning experiences.

4.4 Authentication of student work

It is essential that judgments of student achievement be made on genuine student assessment responses. Teachers should ensure that students' work is their own, particularly where students have access to electronic resources or when they are preparing collaborative tasks.

The QSA's *A–Z of Senior Moderation* contains a strategy on authenticating student work <www.qsa.qld.edu.au/10773.html>. This provides information about various methods teachers can use to monitor that students' work is their own. Particular methods outlined include:

- teachers seeing plans and drafts of student work
- student production and maintenance of evidence for the development of responses
- student acknowledgment of resources used.

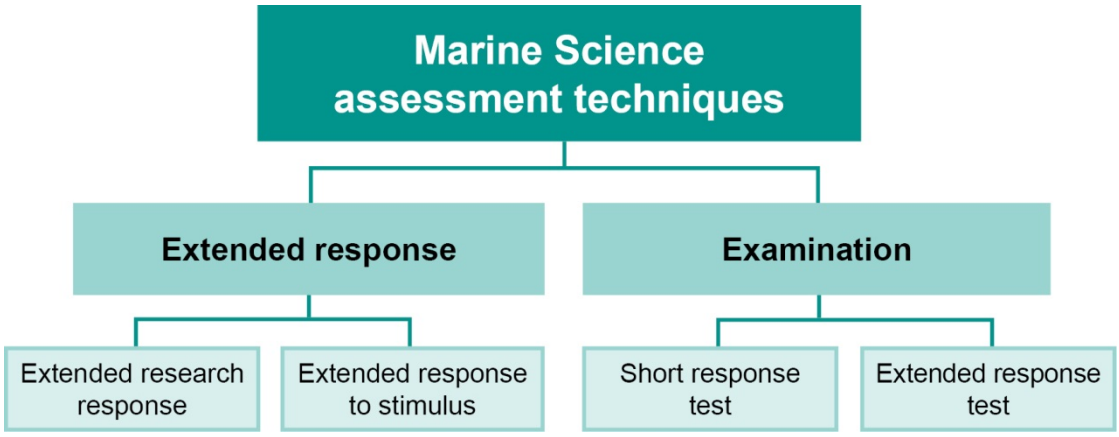
Teachers must ensure students use consistent accepted conventions of in-text citation and referencing, where appropriate.

Further advice on drafting of student assessment responses is available on the Marine Science subject page of the QSA website <www.qsa.qld.edu.au/20319.html>.

4.5 Assessment techniques

The assessment techniques relevant to this syllabus are identified in Figure 4, and described in detail in Sections 4.5.3 and 4.5.4.

Figure 4: Marine Science assessment techniques



Schools design assessment instruments from the assessment techniques relevant to this syllabus. For each assessment instrument, schools develop an instrument-specific standards matrix by selecting the syllabus standards descriptors for the dimension/s to be assessed. The matrix is used as a tool for making judgments about the quality of students' responses to the instrument and is informed by the syllabus standards descriptors. Assessment is designed to allow students to demonstrate the range of standards (see Section 4.8.2, Awarding exit levels of achievement). Teachers give students an instrument-specific standards matrix for each assessment instrument.

Where students undertake assessment in a group or team, instruments must be designed so that teachers can validly assess the work of individual students and not apply a judgment of the group product and processes to all individuals.

The assessment instruments students respond to in a Year 11 assessment program should support those included in Year 12.

The conditions of assessment, possible modes for assessment and supporting evidence are identified and described below.

4.5.1 Conditions of assessment

Over a four-semester course of study, students are required to complete assessment under a range of conditions (see Section 4.1.2, Balance).

Conditions may vary according to assessment. Conditions should be stated clearly on assessment instruments and may include:

- whether supervised or unsupervised
- indicating individual, group or team
- stating time allowed (with perusal time as needed)
- stating length required
- using seen or unseen questions
- using sources or technologies.

Where support materials or technologies (e.g. notes, calculators or computers) are used under supervised conditions, schools must ensure that the purpose of supervised conditions (i.e. to authenticate student work) is maintained.

4.5.2 Modes of assessment

Assessment techniques may be presented in a variety of modes, e.g. written, spoken/signed and multimodal. An assessment response is communicated to an audience for a particular purpose which may influence the type of text, language features and other textual features used in the response. Purposes may include analysing; persuading; arguing; informing; presenting investigative, experimental or field-based findings; creating; performing; showcasing; reviewing a text or situation; completing calculations or solving problems.

Referencing conventions must be followed regardless of the mode of assessment.

Written responses

Written responses require students to communicate a written assessment response to an audience for a particular purpose.

Spoken responses

Spoken responses require students to present a spoken assessment response to a live or virtual audience (i.e. through the use of technology) for a particular purpose.

Multimodal responses

A multimodal response uses a combination of at least two modes to communicate an assessment response to a live or virtual audience for a particular purpose.

Modes include:

- written
- spoken/signed
- nonverbal, e.g. physical, visual, auditory.

Each of the selected modes contributes significantly to the multimodal response.

Different technologies may be used in the creation or presentation of the response. Replication of a written document into an electronic or digital format does not constitute a multimodal response.

When making judgments about multimodal responses, teachers apply the standards to the entire response — that is to all modes used to communicate the response.

Supporting evidence

Supporting evidence is required to substantiate decisions made on spoken and multimodal responses for monitoring, verification and exit purposes. Evidence to support spoken or multimodal responses may include:

- research/data analyses
- notes or annotations
- summary of findings
- journal entries or log book
- seminar brief or conference paper
- a recording of the response (as appropriate).

4.5.3 Extended response

Assessment technique: Extended response

Purpose

Extended response assesses the sustained application of higher order cognition (analysis, interpretation, evaluation, and development and justification of conclusions, decisions and recommendations) in responding to research or stimulus materials. Students analyse, interpret and evaluate data and information relating to marine environment, issues or problems to develop and justify conclusions, decisions and recommendations.

Dimensions to be assessed

The dimensions to be assessed should be clearly stated on assessment instruments. This assessment technique is best used to determine student achievement in objectives from the dimensions:

- *Knowledge and understanding*
- *Investigation and analysis*
- *Evaluation and communication*.

Types of extended response

Extended research response

- An extended research response involves students collecting, selecting, organising and using information that goes beyond the data students have been given and the knowledge they currently possess.
- An extended research response occurs over a set period of time. Students may use class time and their own time to conduct research and develop a response.
- Examples of specialised extended research responses relevant to this subject include:
  - Extended marine investigation
  - Action research.

Specialised extended research response: Extended marine investigation

- Extended marine investigations (EMIs) involve the observation and/or manipulation of variables relevant to marine environments.
- EMIs can occur in two ways:
  - in marine environments, students identify variables that occur within the environment and that affect marine organisms or environments, conducting correlational investigations into these effects (e.g. distribution of intertidal marine organisms)
  - in environments where variables can be controlled and manipulated (e.g. laboratory), students identify and manipulate variables that affect marine organisms or environments (e.g. the effects of overcrowding on marine organisms, the effects of wave action on nutrient cycling).
- In both situations, students complete open-ended, practical research using laboratory and/or field-based methods to collect primary data.
- EMIs take several weeks to complete, including time for students to conduct initial research (drawing on primary and/or secondary sources), plan investigations, collect data and information, and develop a research response.
- While EMIs may not be the sole focus of a unit of work, it is expected that learning experiences will be relevant to the topic of the assessment.
- In conducting EMIs, students:
  - follow an inquiry-based investigation process
  - formulate research questions, hypotheses and plans for investigation
  - complete risk assessments to analyse and mitigate potential hazards and ensure animal welfare and ethics requirements are met
  - collect, select and organise marine information from primary and/or secondary sources, including the construction of graphical representations
  - analyse and interpret information, identifying and explaining relationships, trends and patterns
  - evaluate information to draw conclusions and make decisions and recommendations, including modifications to equipment and procedures

Assessment technique: Extended response

  - justify conclusions, decisions and recommendations
  - communicate to audiences through a written, spoken or multimodal research response
  - maintain a scientific journal to accompany the response.
- The main aims of the scientific journal are to:
  - maintain a log of the stages of the inquiry-based investigation, including modifications to equipment and procedures
  - note the primary data collected by the student in the laboratory or field.
- Common elements of a scientific journal include: research questions, hypotheses and plans for marine investigations, primary data collection and organisation, and conclusions, decisions and recommendations, including modifications
- Scientific journals do not contribute to the word limit, but may be used to support judgments about the objectives. The journal or sections of the journal may be included in the verification folio if required to substantiate teacher judgments.

Specialised extended research response: Action research

- Action research may be used when actively investigating issues or problems in marine environments.
- Action research involves students using their knowledge to formulate a plan for an investigation. The plan may change and evolve over the course of the research process as students gain more or different knowledge.
- Students primarily gain knowledge through first-hand experiences as they gather primary information. This may include interviewing stakeholders.
- Action research involves the use of marine research skills. Marine research skills may be used to enter marine environments under study to gain an appreciation of or a perspective on the environment that will help the investigation. Primary data may be gathered through using marine research skills.
- Action research may be based on the extent to which a variable impacts on a marine environment. For example, “To what extent does tourism / port development / fishing / recreational boating impact on this marine environment?”
- Broad action research projects relating to a marine environment, issue or problem may give rise to an EMI.
- Over the course of the action research, evidence must be gathered to show that students:
  - formulate questions, hypotheses or plans for investigation (may be cyclical)
  - develop and use marine research skills (e.g. video evidence, photographs, blog entries, journals, written or spoken peer and teacher observations/checklists)
  - complete risk assessments for activities to analyse and mitigate potential hazards
  - collect and organise marine information (primary and secondary)
  - analyse and interpret marine information, identifying and explaining relationships, trends and patterns
  - evaluate the action research outcomes and processes, drawing conclusions, and making decisions and recommendations. All conclusions, decisions and recommendations must be justified.
- Students may wish to maintain a scientific journal to accompany the response. For further detail on scientific journals, see Extended marine investigation.

Extended response to stimulus

- An extended response to stimulus involves students responding to stimulus materials related to marine environments, issues or problems.
- Stimulus materials are known or provided materials/sources and concepts. This may include articles, documentaries, case studies, environmental reports, images, quotes and statistics.
- An extended response to stimulus occurs over a set period of time. Students may use class time and their own time to develop a response.
- While research may occur in the writing of the extended response to stimulus, it is not the focus of this technique.
- Students respond to a seen question or statement using data, researched information, primary and/or secondary sources.

Assessment technique: Extended response

Possible assessment instruments

Assessment instruments that may be developed to assess extended response include:

- essay, e.g. analytical, persuasive/argumentative, informative
- report, e.g. investigative, experimental, field-based, practical, action research
- article, e.g. magazine or journal, may be analytical, persuasive, informative
- speech, e.g. analytical, persuasive/argumentative or informative
- interview or debate
- news segment or documentary
- webcast or podcast
- a presentation combining speaking with data presentation or slide show
- a seminar combining speaking with visual prompts, e.g. posters, brochures, handouts
- a digital presentation or documentary combining images, sound bites, blog entries and embedded videos.

Assessment conditions	Year 11	Year 12
Written:		
• extended research response	800–1000 words	1000–1500 words
• extended response to stimulus	600–1000 words	800–1200 words
Spoken:	3–4 minutes	4–5 minutes
Multimodal:	3–5 minutes	5–7 minutes

Further guidance

Teachers who wish to offer an extended response as a test (supervised conditions) should refer to the assessment technique: Examination (see Section 4.5.4).

4.5.4 Examination

Assessment technique: Examination

Purpose

This technique assesses the application of a range of cognition (knowledge, understanding, application, analysis, evaluation) to responses completed under supervised conditions.

Dimensions to be assessed

The dimensions to be assessed should be clearly stated on assessment instruments. This assessment technique is best used to determine student achievement in objectives from the dimensions:

- *Knowledge and understanding*
- *Investigation and analysis*
- *Evaluation and communication*.

Types of examination

Short response test

- Short response tests typically consist of a number of items, which involve students responding to questions, problems and scenarios.
- Short response tests occur under supervised conditions as students produce work individually and in a set time to ensure authenticity.
- Items will be in response to questions or statements. Questions or statements are typically unseen. If seen, teachers must ensure the purpose of this technique is not compromised.
- Stimulus materials may also be used and may be seen or unseen.
- Unseen questions, statements or stimulus materials should not be copied from information or texts that students have previously been exposed to or have directly used in class.
- Items may include activities that require:
  - explanations longer than one sentence
  - ideas maintained, developed and justified
  - full sentence responses, constructing a piece of prose that may have one or several paragraphs.
- Items may require students to construct, use, interpret or analyse primary or secondary data, graphs, tables or diagrams.
- Items may also include multiple-choice and sentence answers. These types of questions, while useful for assessing content knowledge, are difficult to construct if trying to elicit meaningful higher order cognitive responses.

Extended response test

- Extended response tests require students to demonstrate sustained analysis, synthesis and evaluation in their responses.
- Extended response tests occur under supervised conditions where students produce work individually in a set time to ensure authenticity.
- Students respond to stimulus materials that may be seen or unseen, and a seen or unseen question or statement.

Assessment conditions	Year 11	Year 12
Recommended duration:	1–1.5 hours	1.5–2 hours
Short response test:	50–250 words per response	50–250 words per response
Extended response test:	400–600 words per response	600–800 words per response

Further guidance

Teachers who wish to offer an extended response but not as a test (i.e. not under supervised conditions) should refer to the assessment technique: Extended response (see Section 4.5.3).

4.6 Verification folio requirements

A verification folio is a collection of a student's responses to assessment instruments on which the interim level of achievement is based. For students who are to exit after four semesters, each folio should contain the range of assessments for making summative judgments as stated below.

Students' verification folios for Marine Science are to contain a minimum of four and a maximum of six assessment instruments and the relevant student responses. Each folio must include:

- evidence of student work from Year 12 only
- evidence of each instrument assessing at least two dimensions with each dimension being assessed at least three times
- one extended marine investigation or action research assessing all three dimensions (see Section 4.5.3)
- one supervised extended response test (see Section 4.5.4)
- a student profile completed to date.

For information about preparing monitoring and verification submissions, schools should refer to QSA's *Moderation handbook for Authority subjects,* <www.qsa.qld.edu.au/10773.html>.

4.6.1 Post-verification assessment

In addition to the contents of the verification folio, there must be at least one subsequent summative assessment in the exit folio completed after verification. For this syllabus, students are to complete an assessment response which assesses all three dimensions.

4.7 Exit standards

Standards are used to make judgments about students' levels of achievement at exit from a course of study. The standards are described in the same dimensions as the objectives of the syllabus. The standards describe how well students have achieved the objectives and are stated in the standards matrix.

The following dimensions must be used:

Dimension 1: *Knowledge and understanding*

Dimension 2: *Investigation and analysis*

Dimension 3: *Evaluation and communication.*

Each dimension must be assessed in each semester, and each dimension is to make an equal contribution to the determination of exit levels of achievement.

Each dimension must be assessed in each year of the course, and each dimension is to make an equal contribution to the determination of exit levels of achievement.

4.8 Determining exit levels of achievement

When students exit the course of study, the school is required to award each student an exit level of achievement from one of the five levels:

- Very High Achievement (VHA)
- High Achievement (HA)
- Sound Achievement (SA)
- Limited Achievement (LA)
- Very Limited Achievement (VLA).

All the principles of exit assessment must be applied when making decisions about exit levels of achievement.

Exit levels of achievement are summative judgments made when students exit the course of study. For most students this will be after four semesters. For these students, judgments are based on exit folios providing evidence of achievement in relation to all objectives of the syllabus and standards.

For students who exit before completing four semesters, judgments are made based on the evidence of achievement to that stage of the course of study and the principles of exit assessment.

4.8.1 Determining a standard

The standard awarded is an on-balance judgment about how the qualities of the student's responses match the standards descriptors in each dimension. This means that it is not necessary for the student responses to have been matched to every descriptor for a particular standard in each dimension.

4.8.2 Awarding exit levels of achievement

When standards have been determined in each of the dimensions for this subject, Table 5 below is used to award exit levels of achievement, where A represents the highest standard and E the lowest. The table indicates the minimum combination of standards across the dimensions for each level.

Table 5: Awarding exit levels of achievement

VHA	Standard A in any two dimensions and no less than a B in the remaining dimension
HA	Standard B in any two dimensions and no less than a C in the remaining dimension
SA	Standard C in any two dimensions and no less than a D in the remaining dimension
LA	At least Standard D in any two dimensions and an E in the remaining dimension
VLA	Standard E in the three dimensions

Further information is available in the QSA's *Moderation handbook for Authority subjects*, <www.qsa.qld.edu.au/10773.html>.

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4.8.3 Standards matrix

	Standard A	Standard B	Standard C	Standard D	Standard E
Knowledge and understanding	The student work has the following characteristics: • thorough definition and description of marine science concepts • thorough explanation of marine systems using a comprehensive range of concepts and models • discerning and systematic application of understandings to marine environments, issues and problems.	The student work has the following characteristics: • definition and detailed description of marine science concepts • detailed explanation of marine systems using a range of concepts and models • systematic application of understandings to marine environments, issues and problems.	The student work has the following characteristics: • definition and description of marine science concepts • explanation of marine systems using concepts and models • application of understandings to marine environments, issues and problems.	The student work has the following characteristics: • definition or simple description of marine science concepts • simple explanation of marine systems using some concepts and models • simple application of understandings to marine environments.	The student work has the following characteristics: • statement of aspects of marine science concepts • statement of aspects of marine systems • statement of marine science concepts, models or systems somewhat related to marine environments.
Investigation and analysis	The student work has the following characteristics: • formulation of purposeful and relevant questions, hypotheses and thorough plans for marine investigations • purposeful and methodical collection of reliable primary data using marine research skills • purposeful and methodical selection and organisation of marine information from reliable and valid primary and secondary sources • thorough analysis and interpretation of marine information to identify and explain relationships, trends and patterns.	The student work has the following characteristics: • formulation of relevant questions, hypotheses and detailed plans for marine investigations • methodical collection of primary data using marine research skills • methodical selection and organisation of marine information from valid primary and secondary sources • detailed analysis and interpretation of marine information to identify and explain relationships, trends and patterns.	The student work has the following characteristics: • formulation of questions, hypotheses and plans for marine investigations • collection of primary data using marine research skills • selection and organisation of marine information from primary and secondary sources • analysis and interpretation of marine information to identify and explain relationships, trends and patterns.	The student work has the following characteristics: • formulation of simple questions or hypotheses and use of given plans for marine investigations • collection of some primary data using marine research skills • partial organisation of marine information from primary or secondary sources • simple analysis and interpretation of some marine information to identify some relationships or patterns.	The student work has the following characteristics: • use of given questions or plans for marine investigations • statement of primary data • statement of marine information from primary or secondary sources • identification and basic explanation of relationships or patterns.

	Standard A	Standard B	Standard C	Standard D	Standard E
Evaluation and communication	The student work has the following characteristics: • thorough evaluation of marine information to draw logical conclusions and make purposeful and relevant decisions and recommendations • reasoned and valid justification of conclusions, decisions and recommendations about marine environments, issues and problems • coherent and clear communication using well-chosen language conventions to suit audiences and purposes.	The student work has the following characteristics: • detailed evaluation of marine information to draw logical conclusions and make relevant decisions and recommendations valid justification of conclusions, decisions and recommendations about marine environments, issues and problems clear communication using appropriate language conventions to suit audiences and purposes.	The student work has the following characteristics: • evaluation of marine information to draw conclusions and make decisions and recommendations • justification of conclusions, decisions and recommendations about marine environments, issues and problems • communication using language conventions to suit audiences and purposes.	The student work has the following characteristics: • simple conclusions drawn and basic recommendations made • simple justification of conclusions or recommendations • communication using inconsistent language conventions.	The student work has the following characteristics: • statement of opinions • inconsistent use of evidence to support opinions • communication using language conventions which impede meaning.

5 Glossary

Term	Explanation
analyse	dissect to ascertain and examine constituent parts and/or their relationships; consider in detail for the purpose of finding meaning or relationships, and identifying patterns, similarities and differences
apply	employ knowledge in a particular situation
appropriate	fitting, suitable to the context
aspects	components, elements
audience	the intended group of readers, listeners or viewers that the writer or speaker is addressing
basic	fundamental; elementary or simple
clear	plain and open, without ambiguity
coherent	rational with parts that are harmonious, well-structured and that make sense
collect	gather
communicate	convey information about, make known, clearly reveal or make known
comprehensive	of broad scope or content; including all relevant details
concept	in the context of Marine Science, a concept is a basic or fundamental idea, notion or element; may include terminology specific to the subject
conclusion	a judgment based on evidence
considered	thought about or decided upon with care
consistent	accordant; in agreement or harmony; congruent
context	a framework for the development of meaningful learning experiences which provide students with opportunities to learn in circumstances that are relevant and interesting to them and are used to bring aspects of the areas of study together in real-world scenarios
contrast	display recognition of differences by deliberate juxtaposition of contrary elements
decision	a choice or determination formed following the consideration of alternatives
define	state the precise meaning of
describe	provide an account of features
detailed	including numerous facts or aspects
discerning	showing good judgment; selected for value or relevance
effective	meeting the assigned purpose
equipment	specialised device or apparatus used for a particular purpose; may be used in the laboratory or the field
explain	present a meaning with clarity, precision, completeness, and with due regard to the order of statements in the explanation; provide additional information that demonstrates understanding

Term	Explanation
evaluate	examine and judge the merit or significance of something, including processes, descriptions, relationships or data, according to criteria
formulate	devise, construct, produce
given	known or provided
identify	establish or indicate what something is
impede	hamper, limit, block or decrease the action or function of
inconsistent	lacking harmony between the different parts or elements; discrepant; incongruous
information	knowledge or data gained through experimentation, research and the use of primary and secondary sources
inquiry	a process involving the application of research techniques to the investigation of issues (see Section 3.1.2 for more detail)
interpret	explain the meaning of information or actions
interrelationship	the connection or association between ideas or between components of systems and models
investigation	a process of answering a question, exploring an idea or solving a problem
issues	current and relevant topics that cause concern or that are open to discussion or debate
justify	provide sound reasons or evidence to support a statement; soundness requires that the reasoning is logical and, where appropriate, that the premises are likely to be true
language conventions	the features of language that support meaning and help convey meaning (e.g. spelling, terminology, vocabulary, grammar, punctuation, sentence structure, paragraphing, referencing, genre, mode)
logical	rational and valid, internally consistent
methodical	arranged or proceeding in regular, systematic order
models	representations that describe and simplify relationships between concepts
modification	change or alteration in form, design or practice
organise	to arrange methodically to form an ordered whole
partial	incomplete
pattern	an arrangement of corresponding parts; may be based on a representative sample
plans	methods, procedures, techniques or a progression of stages employed to accomplish a set goal
primary data	information created by the person or persons directly involved in a study, mainly generated through experimentation
problem	a question proposed for solution
provided	given
purpose	the reason for which something is done, to achieve an intended result

Term	Explanation
purposeful	intentional, determined, meeting an aim
range	a number of different things of the same general type; breadth
reasoned	logical and sound thinking
recommendation	a proposal for an appropriate course of action
relationship	the connection or association between ideas or between components of systems and models
relevant	applicable, important and correct
reliable	dependable, consistent
representation	words, images, symbols or signs used to convey meaning
secondary data	information that has been compiled from primary sources by a person or persons not directly involved in the study, collected through researching the studies and works of others
select	to choose in preference to another or others
sequence	determine the arrangement of constituent parts
significant	important in effect or meaning
simple	may concern a single or a basic aspect, few steps, obvious data/outcomes, limited or no relationships
specific	intended for, applying to, or suited to a particular purpose, explicitly set forth
superficial	apparent and sometimes trivial
system	groups of interacting concepts or processes that form an integrated whole
systematic	methodical, organised and logical
thorough	demonstrating depth and breadth, inclusive of relevant detail
trend	the general direction in which something (namely data) tends to move
understandings	in the context of Marine Science, understandings refer to the demonstrated knowledge of marine science concepts, models and systems when identified and explained in the context of a marine environment issue or problem
valid	applicable, legitimate and defensible
well-chosen	carefully selected to produce a desired effect

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