Draft Senior Secondary Australian Curriculum Science

Consultation Report
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1 Executive summary

Introduction

There was in-principle support for an Australian senior years Science curriculum for the broad range of students that includes contemporary 20th- and 21st-century science. It was clearly identified that the subject content must provide students with opportunities to engage in science inquiry learning to develop their understanding of science concepts/ideas and of the nature and development of science. The senior years Science subjects must also balance the provision of the understanding and skills needed by all students to become informed citizens, able to engage critically with contemporary issues, with the developing of foundations for the small number of students continuing into future science-based careers and further study. Significant concerns were raised in relation to the four draft Australian science curriculum subjects in addressing this balance in terms of the excess amount, appropriateness and level of cognitive demand of the content. The quality of the subjects in relation to the structure, the clarity of concepts/ideas, and the limited opportunity for inquiry-based learning were also of major concern.

Key matters

- The language of the subject rationale should be appropriate for the broad audience of teachers, students and parents.
- The wording of some parts of the aims of all subjects lacks clarity.
- The structure and content of the subjects do not support the intent of the rationale and aims.
- The sequential organisation of the four units is necessary to provide a conceptual framework for the logical, coherent development of understanding and the flexibility to contextualise the content.
- There is an excessive amount of content to be addressed in the allocated 50–60 hours.
- The amount of content included in the subjects provides limited opportunities for learning through science inquiry and for extended scientific investigations.
- In all subjects, there is a large number of content descriptions that lack clarity, are inaccurate, and include errors and misconceptions. For example, in Chemistry, the process for obtaining biodiesel is purification, not synthesis; in Physics, projectile motion is incorrectly identified as taking place in all inertial frames; and in Biology, the biosphere is not in dynamic equilibrium, as the amount of energy entering the biosphere exceeds that leaving.
- The cognitive demand of some content in the Science Understanding (SU) and Science as a Human Endeavour (SHE) strands and the mathematical requirements included are beyond the level of development of the majority of students in senior years.
- The content of the subjects does not appropriately balance relevant science learning for the range of students in their adult life and the provision of a foundation for the small number of students intending further science or science-related study at the tertiary level.
- The subjects do not cater for the broad range of students but are aimed at the small group of high-achieving, academic students intending to continue into tertiary science-based studies.
- The general capabilities and the cross-curriculum priorities, with the possible exception of sustainability, are not explicitly represented in the content.

Recommendations to ACARA

- The language of the rationales should be revised to take into account the broader audience and the clarity of the wording of the aims should be reviewed.
- The intent of the rationale and the aims should be consistent with and supported by the subject structure and content descriptions.
- The units should provide a conceptual framework through the sequential organisation of key concepts/ideas necessary to develop the core understanding and skills appropriate for the range of students.
- The amount of content should be significantly reduced to that which is achievable in the time available to schools.
- The relationship between the strand content should be clear and the amount of SU and SHE content should be reduced to provide adequate time for students to learn through a science inquiry approach that will develop deep understanding.
- There should be a major review of all content descriptions to ensure clarity, scientific accuracy and an appropriate level of cognitive demand for the range of senior secondary students.
- The content descriptions in the SU and SHE strands should be reduced to broad statements of the key concepts/ideas that are appropriate for the range of students.
- The general capabilities and cross-curriculum content should be clearly identifiable and should be able to be authentically addressed in the time available to schools in senior years.

2 Background information

The Australian Curriculum, Assessment and Reporting Authority (ACARA) released the draft senior secondary Australian curriculum for the English, Mathematics, Science and History learning areas for national consultation from 10 May until 20 July 2012.

ACARA has an established timeline that includes further curriculum refinement to follow the consultation period. It is anticipated that the final senior secondary Australian curriculum for English, Mathematics, Science and History, including content and achievement standards, will be ready for publication following Ministerial endorsement in December 2012.

The focus of the Board's consultation was on the draft senior secondary Australian curriculum content. This consultation was part of a process for developing the NSW approach to integrating the Australian curriculum content into NSW syllabuses. The Board of Studies consulted with teachers, stakeholders and the public through focus group meetings in metropolitan and regional centres and through an online survey. The Board will provide ACARA with formal NSW feedback about the quality and suitability of the curriculum.

At this stage, there is no timetable for implementation of the senior secondary Australian curriculum in NSW.

The NSW consultation consisted of:

- focus group meetings at:
  - Offices of the Board of Studies:
    - Stakeholder focus group on 21 June 2012 (Stakeholder FG)
    - Sydney focus group on 28 June 2012 (Sydney FG)
    - Biology focus group on 29 June 2012 (Biology FG)
    - Chemistry focus group on 3 July 2012 (Chemistry FG)
    - Physics focus group on 3 July 2012 (Physics FG)
    - Earth and Environmental Science focus group on 19 July 2012 (EES FG)
  - Newcastle on 16 July 2012 (Newcastle FG)
  - Wagga Wagga on 26 July 2012 (Wagga Wagga FG)
- an online survey on the Board of Studies website from 8 June to 27 July 2012
- written submissions received from:
  - the Agricultural Institute of Australia (AIA)
  - the Catholic Education Office of Sydney (CEOSYD)
  - the Department of Education and Communities (DEC)
  - the Science Teachers' Association of NSW (STANSW)
  - eight individuals (Submissions 1–8).

Professional associations and schooling sectors conducted a range of activities during the consultation period to inform feedback to the Board.

3 Analysis

3.1 Rationale

Overall comments

Feedback identified that the rationales provided the broad scope and distinctive nature for a senior years Science subject, but that the structure and content of the subjects are not supportive of the rationale intent. Respondents commented that the language of the rationales should be reviewed to take into account the broader audience.

Summary of feedback	Source(s)
All subjects	
• The intent of the rationales is not evident in the content of the subjects.	Stakeholder FG, Newcastle FG, Biology FG, Chemistry FG, EES FG, Physics FG
• The language of the rationales is wordy and complex, requiring further definition. It does not take into account that the audience includes teachers, students and parents.	Stakeholder FG, Newcastle FG, Biology FG, Chemistry FG, EES FG, Physics FG, CEOSYD, Survey (×1)
• There are some aspects of the rationales that require strengthening to more accurately represent the importance of senior years Science subjects for the range of students.	Stakeholder FG
• Some of the content of the rationales would be more appropriate to the descriptions of the Science Understanding (SU) and Science as a Human Endeavour (SHE) strands in the section on organisation of content.	Stakeholder FG
Biology	
• The language of the rationale does not engage the audience and includes unfamiliar terminology that requires definition in the glossary. • The rationale wording should be strengthened in relation to molecular biology. • The importance of evolution is stressed in the rationale, but is not reflected in the curriculum content. • The emphasis of the rationale on careers fails to recognise that a senior years subject has a significant role in preparing students to be biologically literate citizens.	Stakeholder FG, Newcastle FG, Biology FG, Submissions 2 and 7
• The wording of the rationale implies that field and laboratory investigations are not research.	Submission 6
Chemistry	
• The language of the rationale is technical and requires definition. It is not taking into account the intended audience.	Stakeholder FG, Chemistry FG

Summary of feedback	Source(s)
Earth and Environmental Science	
• The introductory statement does not clearly define the field of study. • The rationale does not clearly relate to the unit content. • The rationale requires strengthening to make explicit the social and ethical expectations of protection of the environment.	Newcastle FG, EES FG
Physics	
• The rationale does not correlate with the content of the subject. • The last paragraph is inconsistent with the amount of SU content and the focus on calculations.	Stakeholder FG, STANSW, Survey (×1), Submission 5
• The rationale does not clarify the distinction and relationship between models and theories.	Submission 5
• The rationale does not give sufficient emphasis to the quantitative nature of physics.	Submission 3
• The rationale is not appropriate for a pure physics subject for students continuing to university, as it includes too much on the impact on society.	Survey (×2)
• The rationale appropriately focuses on 'doing' physics rather than learning about physics.	Survey (×1)

3.2 Aims

Overall comments

Across the four subjects, consultation feedback noted that the aims described the intended learning of the study of a senior years Science course. The clarity of wording and the enabling of the intent of the aims through the structure and content of the subjects were matters identified for further development.

Summary of feedback	Source(s)
Biology	
• Points 2 and 6 of the aim are unclear.	Stakeholder FG, Biology FG
• It is unclear how, given the amount of content, the study of the curriculum could achieve point 1 of the aim.	Submissions 2 and 7
• The aims are broad and vague.	Submission 7
Chemistry	
• The intent of the aim is not apparent in the content. • It is questioned whether point 5 in the aim is achievable at the school level.	Chemistry FG
Earth and Environmental Science	
• The relationship between the intent of the aim and the content needs to be improved.	EES FG, Survey (×1)
• The organisation and sequencing of the content should relate to the aims.	Survey (×1)
Physics	
• The intent of the aim is not consistent with the subject content. • It is not possible to achieve point 1 of the aim with the current amount of content.	Stakeholder FG, Sydney FG, Physics FG
• The relationship between theories/models in the aim and the emphasis on models in the rationale could be strengthened.	Submission 5
• A statement identifying mathematics as the language of physics could be included in either point 2 or point 3 of the aim.	Survey (×1)
• The aim should include problem-solving as a major emphasis in the Physics subject, as it is an essential skill for university preparation.	Submission 3

3.3 Organisation of content

Overall comments

Feedback from consultation identified that the four-unit structure does not provide a conceptual framework in which there is a logical, coherent development of understanding and flexibility to contextualise the content. For the four-unit structure to be workable, it must be sequential and there must be sufficient time to develop the foundation underpinning understanding and skills in Units 1 and 2 that will be further developed in Units 3 and 4. The time allocation of 50–60 hours is unrealistic for the amount of content in all units and needs to be reduced. The Science Understanding (SU) and Science as a Human Endeavour (SHE) content should be the core understanding and skills for the broad range of students. Respondents provided a range of specific comments that should be addressed relating to the sequencing and organisation of content within the units and across the subject.

Summary of feedback	Source(s)
All subjects	
• The subject structure lacks internal logic and coherence unless Units 1 and 2 are prerequisites for and build the foundation knowledge and skills required for Units 3 and 4.	Stakeholder FG, Sydney FG, Newcastle FG, CEOSYD
• The organisation of subjects with four 'stand-alone' units does not provide a conceptual framework in which there is a logical and coherent development and sequencing of understanding. • The sequence of units should provide a hierarchical development of concepts, ideas and skills.	Submission 5
• The organisation of the content within and across units shows inconsistencies in the sequencing and development of concepts and ideas.	Survey (×2)
• A subject structure where each unit requires equal time to be delivered is not feasible within the hours available to schools in each of Year 11 and Year 12 (ie the shorter second semester in Year 12). • It is not possible to determine if there is adequate time to complete a unit and/or the course, as there is insufficient clarity in the content descriptions to determine the depth of treatment required.	Stakeholder FG, Sydney FG, Newcastle FG, Wagga Wagga FG, CEOSYD, STANSW
• The amount and conceptual demand of SU and SHE content will result in insufficient time to focus on the processes of science inquiry and to develop the skills needed for students to undertake extended scientific investigations.	Stakeholder FG, Sydney FG, Newcastle FG, Wagga Wagga FG, Biology FG, Chemistry FG, Physics FG
• The SU and SHE content should be reduced to broad statements of the core understanding and skills. • The four-unit structure of the curriculum limits the flexibility to contextualise the content to make it meaningful and relevant.	Stakeholder FG, Biology FG, Physics FG, DEC, STANSW
• The four-unit structure does not allow the flexibility for the inclusion of options.	Survey (×2)

Summary of feedback	Source(s)
• Within the units, there is no clear interrelationship between the content of SHE and that of SU and Science Inquiry Skills (SIS). • It is not clear how the three strands could be closely integrated to provide students with a multifaceted view of science. • The organisation of specific SU and SHE content into subunits within each unit limits the scope and flexibility to contextualise the content.	Stakeholder FG, Newcastle FG, Wagga Wagga FG, Biology FG, Physics FG
• The learning outcomes lack clear links to the SIS, SU and SHE content. • The use of the word 'understand' in the outcomes is not measurable and does not describe the expected learning.	Stakeholder FG, Newcastle FG, Wagga Wagga FG, Biology FG
Biology	
• The time allocation for each unit is unrealistic for the amount and demand of content and is inadequate for students to master complex knowledge and skills.	Stakeholder FG
• There is insufficient time to cover Units 3 and 4, which are more content-heavy and more cognitively demanding.	Submission 7
Chemistry	
• The units are large and contain too much content. • Units 3 and 4 require more than 60 hours for the content to be addressed.	Stakeholder FG, Sydney FG, Wagga Wagga FG
• There is variation between units in the amount of content and the time that would be required to teach the content. • The ordering of the unit content needs to be revised to develop the underpinning concepts required for the understanding of more advanced concepts later in the course.	Survey (×1), Submissions 4 and 8
Earth and Environmental Science	
• Units 1, 2 and 3 are too large for the 50–60 hours. • Units 3 and 4 are not necessarily more cognitively demanding than Units 1 and 2.	Sydney FG, Newcastle FG, EES FG, Submission 1
Physics	
• The organisation into subunits within each unit has resulted in there being too much content in Units 1, 2 and 3. • Unit 1 content is exceptionally diverse and detailed.	Stakeholder FG, Sydney FG, Wagga Wagga FG, Physics FG
• There are several areas in which there is a lack of logical connection, sequencing and/or hierarchical development of concepts within the units and across the subject as a result of the four-unit structure.	Submissions 3 and 5
• Greater flexibility in the unit structure is required to allow the SU and SHE content to be developed within contexts relevant to students.	DEC, STANSW
• Unit 2 would be a more appropriate starting point for Year 11, as its content is more accessible.	Survey (×2)

3.4 Content descriptions

Overall comments

Feedback identified significant concerns about the excessive amount of content in all subjects. The content described in the SU and SHE strands should be reduced to broad statements of key concepts/ideas that are appropriate to the needs of the range of students. The time required to address the amount of content significantly limits the opportunities for students to engage in learning through science inquiry or to undertake extended scientific investigations. The cognitive demand of some areas of scientific knowledge and understanding and the mathematical requirements included in all subjects cater only for the top students. Respondents provided a range of specific comments relating to lack of clarity, inaccuracies and misconceptions in the content in all subjects

Summary of feedback	Source(s)
• There is inconsistency between the unit descriptions and the content descriptions. • The learning outcomes do not correlate with the content descriptions in SIS, SHE and SU. • The learning outcomes do not clarify the intended depth of the expected learning in the unit.	Stakeholder FG, Sydney FG, Newcastle FG, Wagga Wagga FG, Biology FG, CEOSYD
• There is too much content to develop any depth of treatment; more guidance of depth is needed. • The content descriptions need to be reduced to explicit statements of the core concepts, principles and ideas that are developed logically and coherently within a conceptual framework. • The SHE content descriptions include 'hidden' content not covered in SU and SIS, making it difficult to relate the strands and adding to the cognitive load. • The amount of content included in the content descriptions provides limited opportunities for inquiry-based learning or for extended investigations.	Stakeholder FG, Sydney FG, Newcastle FG, Wagga Wagga FG, Biology FG, Chemistry FG, EES FG, Physics FG, STANSW, Survey (×3)
Science Understanding (SU) • The content descriptions describe a level of difficulty that does not cater for the broad range of students. • The content descriptions do not clearly identify the core understanding and skills that are required by the broad range of students by the end of their senior years of schooling to prepare them for adult life. • The content descriptions include a strong emphasis on statistics and often require mathematical skills, including calculus, beyond the scope of two-unit mathematics. • The content descriptions are inconsistent in demand and in the level of specificity. • Within a unit, the content descriptions are inconsistent in their sequencing and development of the underpinning ideas and concepts.	Stakeholder FG, Sydney FG, Newcastle FG, Wagga Wagga FG, Biology FG, Chemistry FG, EES FG, Physics FG, DEC, STANSW

Summary of feedback	Source(s)
Science Inquiry Skills (SIS) • The SIS content descriptions need to relate clearly to the relevant concepts described in the SU and SHE content descriptions. • The SIS content descriptions are generic and do not show progression of complexity from Units 1 and 2 to Units 3 and 4.	Stakeholder FG, Sydney FG, Newcastle FG, CEOSYD
Science as a Human Endeavour (SHE) • The SHE content descriptions are repetitive in their use of the term 'models', and are inconsistent in their definition and application of the term. • The SHE content descriptions do not relate to SU content descriptions and contain hidden SU content. • The SHE content descriptions include hidden content not covered in SU and SIS, making it difficult to relate the strands and adding to the cognitive load.	Stakeholder FG, Sydney FG, Newcastle FG, Wagga Wagga FG, Biology FG, Chemistry FG, EES FG, Physics FG, Survey (×1)
Biology • There is an overemphasis on ecology, while other areas are not included or are little emphasised, eg disease, origins of life, human evolution, microbiology. • The content descriptions contain inaccuracies and misconceptions, eg the use of the terms 'diversity' and 'biodiversity'.	Biology FG, DEC, Survey (×1) Submissions 2 and 7
Chemistry • The concepts identified in Unit 1 will be challenging for Year 11. • Analytical techniques identified in the content descriptions require access to technology not available in schools.	Stakeholder FG, Sydney FG, Newcastle FG, Chemistry FG, Survey (×1)
Earth and Environmental Science • The content descriptions include very little fieldwork or experimentation in Unit 4; SIS content descriptions relate mostly to the analysis of secondary sources. • There is an overemphasis on geology compared with environmental science. • There is significant overlap of content between Earth and Environmental Science, Biology and Geography.	Sydney FG, EES FG, DEC
Physics • The content descriptions contain inaccuracies and misconceptions, eg mass dilation equation. • The kinetic particle model fits better into Chemistry. • The emphasis on history and sociology is too high and should be reduced to a very small proportion. It is misleading about the nature of physics.	STANSW, Submissions 3 and 5 Survey (×1), Submission 3

3.5 Catering for the full range of students

Overall comments

Feedback from consultation identified strongly that the four subjects were not designed for the range of students but were aimed at the small group of high-achieving academic students intending to continue into tertiary science-based studies.

Summary of feedback	Source(s)
All subjects	
• The subjects do not cater for the range of students and target the small group of university-bound science students.	Stakeholder FG, CEOSYD, DEC, STANSW
• The subjects should include the essential core content and be accessible to the broad range of students.	DEC, STANSW, Survey (×1)
• The amount of content and the significant increase in the level of cognitive demand from Year 10 will limit accessibility to the science subjects for a range of students.	Stakeholder FG, Sydney FG, Newcastle FG, Biology FG
• The level of mathematics will be a limiting factor in the selection of these subjects by a range of students.	STANSW
Biology	
• The breadth of the Biology SU content is similar to that required of first-year university students.	Submission 7
Chemistry	
• The subject is designed for the top group of students and would not be suitable for the range of students currently studying Chemistry in Years 11 and 12.	Wagga Wagga FG
Earth and Environmental Science	
• The academic nature and focus on geology will deter some students and limit accessibility.	Survey (×1)
• The level of mathematics required will limit the range of students selecting the subject.	Submission 1
Physics	
• The subject as designed would not be suitable for the range of students currently studying Physics in Years 11 and 12. • It would be appropriate for there to be another lower-level subject for students who do not have the talent for senior physics.	Wagga Wagga FG
• The Physics subject is aimed at students continuing into science and engineering.	Submission 3

3.6 General capabilities and cross-curriculum priorities

Overall comments

Respondents identified that in all subjects, the cross-curriculum priorities – with the possible exception of sustainability – were not evident in the content. While the general capabilities were identified in the Organisation section, they were not explicitly represented in the content. Significant reduction of the content is required to allow time for the general capabilities and cross-curriculum priorities to be authentically addressed.

Summary of feedback	Source(s)
All subjects	
• The representation of the general capabilities and cross-curriculum priorities is not authentically embedded and the links to the content are not explicit.	Stakeholder FG, Sydney FG, Newcastle FG, Wagga Wagga FG, DEC
• There is insufficient time with the amount of content to develop critical and creative thinking.	DEC, Submission 2
• The diminished emphasis on SIS does not align with the stronger intent to develop critical and creative thinking.	Stakeholder FG, DEC
• There are some general capabilities that are more evident than others; however, these still require strengthening to make them explicit in the content, eg literacy, numeracy, ICT.	Stakeholder FG, Sydney FG, Newcastle FG
• Sustainability in the science subjects should relate to some key issues about the security of food production.	AIA
Biology	
• The general capabilities are not explicitly represented in the content descriptions.	Sydney FG, Newcastle FG, Biology FG
• The cross-curriculum areas are not explicitly represented in the curriculum content.	
• There are missed opportunities to embed Aboriginal and Torres Strait Islander histories and cultures and Asia and Australia's engagement with Asia authentically in the content.	Submission 2
• The statistics requirements need clarification in the description of numeracy and should be explicit in the content.	Biology FG, Submission 2
Chemistry	
• There is evidence of sustainability, but the other cross-curriculum priorities areas are not evident in the content.	Stakeholder FG, Sydney FG, Newcastle FG, DEC
• The scope of ethical understanding needs to be broadened and strengthened in the content.	Chemistry FG, Submission 8
• The amount of curriculum content does not provide time for teachers to engage students in critical and creative thinking.	DEC

Summary of feedback	Source(s)
Earth and Environmental Science	
• The only cross-curriculum priority that is explicitly represented in the content is sustainability.	Sydney FG, EES FG
• Aboriginal and Torres Strait Islander histories and culture is lacking in the content.	Submission 1
Physics	
• The cross-curriculum areas are not clearly evident in the curriculum content.	Wagga Wagga FG, Physics FG
• The scope of ethical understanding should be broader and should be explicit in the content.	
• Some aspects of cross-curriculum and general capabilities areas appear forced. There may be others that are more appropriate to physics.	Newcastle FG, Wagga Wagga FG, Physics FG, STANSW, Survey (×1), Submission 5