



B O A R D O F S T U D I E S
NEW SOUTH WALES

**Draft Senior Secondary Australian Curriculum
Science**

**Consultation Report
September 2012**

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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 twentieth and twenty-first 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 about 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 those small number 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, 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 lack 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 time of 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 are a large number of content descriptions that lack clarity, are inaccurate and include errors and misconceptions for example in the Chemistry, the process for obtaining biodiesel is purification not synthesis; in the Physics, projectile motion is incorrectly identified as taking place in all inertial frames; in the 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 Scientific 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 do 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/science related study at 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 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 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 that the content is at 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 concept/ideas that are appropriate for the range of students.
- The general capabilities and cross-curriculum content should be clearly identifiable and 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 English, Mathematics, Science and History learning areas for national consultation on 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 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

Venue	Date	Group
Offices of the Board of Studies (Sydney)	Thursday 21 June 2012	Stakeholder
Offices of the Board of Studies (Sydney)	Thursday 28 June 2012	Sydney
Offices of the Board of Studies (Sydney)	Friday 29 June 2012	Biology
Offices of the Board of Studies (Sydney)	Tuesday 3 July 2012	Chemistry
Offices of the Board of Studies (Sydney)	Tuesday 3 July 2012	Physics
Offices of the Board of Studies (Newcastle)	Monday 16 July 2012	Newcastle
Offices of the Board of Studies (Sydney)	Thursday 19 July 2012	EES
Offices of the Board of Studies (Wagga Wagga)	Thursday 26 July 2012	Wagga Wagga

- an online survey on the Board of Studies website from 8 June 2012 to 27 July 2012.

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 is 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
<p>All subjects</p> <ul style="list-style-type: none"> The intent of the rationale is not evident in the content of the subjects. 	Stakeholder (FG), Newcastle (FG), Biology (FG), Chemistry (FG), Physics (FG), EES (FG)
<ul style="list-style-type: none"> The language of the rationales is wordy 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), Physics (FG), EES (FG), CEOSYD survey (x1)
<ul style="list-style-type: none"> 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)
<ul style="list-style-type: none"> Some of the content of the rationale would be more appropriate to the descriptions of the SU and SHE strands in the section on Organisation of content. 	Stakeholder (FG)
<p>Biology</p> <ul style="list-style-type: none"> 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. The wording of the rationale implies that field and laboratory investigations are not research. 	Stakeholder (FG), Newcastle (FG), Biology (FG), Submission 2 Submission 7 Submission 6
<p>Chemistry</p> <ul style="list-style-type: none"> The language of the rationale is technical and requires definition. It is not taking into account the intended audience. 	Stakeholder meeting, Chemistry (FG)
<p>Earth and Environmental Science</p> <ul style="list-style-type: none"> 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)

Summary of feedback	Source/s
<p>Physics</p> <ul style="list-style-type: none"> • 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. • The rationale does not clarify the distinction and relationship between models and theories. • The rationale does not give sufficient emphasis to the quantitative nature of physics. • 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. • The rationale appropriately focuses on 'doing' physics rather than learning about physics is appropriate. 	<p>Stakeholder (FG), STANSW, Submission 5, Survey (x1)</p> <p>Submission 5</p> <p>Submission 3</p> <p>Survey (x2)</p> <p>Survey (x1)</p>

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 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
<p>Biology</p> <ul style="list-style-type: none"> • The points 2 and 6 of the aim are unclear. • It is unclear how with the amount of content the study of the curriculum could achieve point 1 of the aim. • The aims are broad and vague. 	<p>Stakeholder (FG), Biology (FG) Submission 2, 7</p> <p>Submission 7</p>
<p>Chemistry</p> <ul style="list-style-type: none"> • 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. 	<p>Chemistry (FG)</p>
<p>Earth and Environmental Science</p> <ul style="list-style-type: none"> • The relationship between the intent of the aim and the content needs to be improved • The organisation and sequencing of the content should relate to the aims. 	<p>EES (FG), survey (x1)</p> <p>Survey (x1)</p>
<p>Physics</p> <ul style="list-style-type: none"> • 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. • In the aim the relationship between theories/models and the emphasis on models in the rationale could be strengthened. • A statement identifying mathematics as the language of physics could be included into either point 2 or 3 of the aim. • The aim should include problem-solving as major emphasis in the Physics subject as it is an essential skill for university preparation. 	<p>Stakeholder (FG), Sydney (FG), Physics (FG)</p> <p>Submission 5</p> <p>Survey (x1)</p> <p>Submission 3</p>

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 sufficient time to develop the foundational, 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 relating to sequencing and organisation of content within the units and across the subject that should be addressed.

Summary of feedback	Source/s
<p>All Subjects</p> <ul style="list-style-type: none"> • The subject structure lacks internal logic and coherence unless units one and two are prerequisites for and build the foundation knowledge and skills required for units three and four. • The organisation of subjects with four ‘stand-alone’ units does not provide a conceptual framework in which there is a logical, coherent development and sequencing of understanding. • The sequence of units should provide a hierarchical development of concepts, ideas and skills. • The organisation of the content within and across units shows inconsistencies in the sequencing and development of concepts and ideas. 	<p>Stakeholder (FG), Sydney (FG), Newcastle (FG), CEOSYD</p> <p>Submission 5</p> <p>Survey (x2)</p>
<ul style="list-style-type: none"> • A subject structure where each unit requires equal time to be delivered is not feasible within the hours available to schools in each of Years 11 and 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. • 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. 	<p>Stakeholder (FG), Sydney (FG), Newcastle (FG), Wagga Wagga (FG), STANSW, CEOSYD</p> <p>Stakeholder (FG), Sydney (FG), Wagga Wagga (FG), Newcastle (FG), Biology (FG), Chemistry (FG), Physics (FG)</p>
<ul style="list-style-type: none"> • 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. • The four unit structure does not allow the flexibility for the inclusion of options. 	<p>Stakeholder (FG), Biology (FG), Physics (FG), DEC, STANSW</p> <p>Survey (x2)</p>
<ul style="list-style-type: none"> • Within the units there is no clear interrelationship between the SHE content and that of SU and SIS. • It is not clear how the three strands could be closely integrated to provide students with a multifaceted view of science. 	<p>Stakeholder (FG), Newcastle (FG), Wagga Wagga (FG), Physics (FG), Biology (FG)</p>

Summary of feedback	Source/s
<ul style="list-style-type: none"> The organisation of specific SU and SHE content into subunits within each unit limits the scope and flexibility to contextualise the content. 	
<ul style="list-style-type: none"> 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)
<p>Biology</p> <ul style="list-style-type: none"> The time allocation for each unit is unrealistic for the amount and demand of content or adequate for students to master complex knowledge and skills. There is insufficient time to cover Units 3 and 4 which are more content-heavy and more cognitively demanding. 	Stakeholder (FG) Submission 7
<p>Chemistry</p> <ul style="list-style-type: none"> The units are large and contain too much content. Units 3 and 4 require more than 60 hours for the content to be addressed. 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 understanding of more advanced concepts later in the course. 	Stakeholder (FG), Sydney (FG), Wagga Wagga (FG) Survey (x1), Submission 4 and 8
<p>Earth and Environmental Science</p> <ul style="list-style-type: none"> 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
<p>Physics</p> <ul style="list-style-type: none"> 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. There are a number of 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. Greater flexibility in the unit structure is required to allow the SU and SHE content to be developed within contexts relevant to the students. Unit 2 would be a more appropriate starting-point for Year 11 as its content is more accessible. 	Stakeholder (FG), Sydney (FG), Wagga Wagga (FG), Physics (FG) Submission 3, 5 STANSW, DEC Survey (x2)

3.4 Content Descriptions

Overall Comments

Feedback identified significant concerns about the excessive amount of content in all subjects. The content described in the Science Understanding (SU) and Science as a Human Endeavour (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 caters 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
<ul style="list-style-type: none"> • There is inconsistency between the unit descriptions and the content descriptions. • The learning outcomes do not correlate with the content descriptions in Science Inquiry Skills (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.
<ul style="list-style-type: none"> • 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), Earth and Environmental Science (FG), Chemistry (FG), Physics (FG), STANSW, Survey (x3)
<p>Science Understanding (SU)</p> <ul style="list-style-type: none"> • 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 2-unit mathematics. • The content descriptions are inconsistent in demand and 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), Physics (FG), Earth and Environmental Science (FG), Chemistry (FG), Biology (FG), DEC, STANSW

Summary of feedback	Source/s
<p>Science Inquiry Skills (SIS)</p> <ul style="list-style-type: none"> • The SIS content descriptions need to be able to be clearly related 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. 	<p>Stakeholder (FG), Sydney (FG), Newcastle (FG), CEOSYD</p>
<p>Science as a Human Endeavour (SHE)</p> <ul style="list-style-type: none"> • The SHE content descriptions are repetitive in the use of the term “models”, and are inconsistent in their definition and application of the term. • 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. 	<p>Stakeholder (FG), Sydney (FG), Newcastle (FG), Wagga Wagga (FG), Chemistry (FG), Earth and Environmental Science (FG), Biology (FG), Physics (FG), Survey (x1)</p>
<p>Biology</p> <ul style="list-style-type: none"> • There is an overemphasis on ecology, while other areas are not included or little emphasised, e.g. disease, origins of life, human evolution, microbiology. • The content descriptions contain inaccuracies and misconceptions e.g. using the terms ‘diversity’ and ‘biodiversity’ 	<p>Biology (FG), DEC, Survey (x1) Submission 2, 7</p>
<p>Chemistry</p> <ul style="list-style-type: none"> • 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. 	<p>Stakeholder (FG), Sydney (FG), Newcastle (FG), Chemistry (FG), Survey (x1)</p>
<p>Earth and Environmental Science</p> <ul style="list-style-type: none"> • The content descriptions include very little field work or experimentation in Unit 4; SIS content descriptions relate mostly to 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. 	<p>EES (FG), Sydney (FG), DEC</p>
<p>Physics</p> <ul style="list-style-type: none"> • The content descriptions contain inaccuracies and misconceptions, e.g. 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. 	<p>STANSW, Submission 3, 5 Survey (x1), Submission 3</p>

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
<p>All subjects</p> <ul style="list-style-type: none"> The subjects do not cater for the range of students and target the small group of university-bound science students. 	Stakeholder (FG), DEC, STANSW, CEOSYD
<ul style="list-style-type: none"> The subjects should include the essential core content for and be accessible to the broad range of students. 	DEC, STANSW Survey (x1)
<ul style="list-style-type: none"> The amount of content and the significant increase in the level of cognitive demand from Year 10 will limit the accessibility to the science subjects for a range of students. 	Stakeholder (FG), Sydney (FG), Newcastle (FG), Biology (FG)
<ul style="list-style-type: none"> The level of the mathematics will be a limiting factor in the selection of these subjects by a range of students. 	STANSW
<p>Biology</p> <ul style="list-style-type: none"> The breadth of the Biology Science Understanding (SU) content is similar to that required of first year university students. 	Submission 7
<p>Chemistry</p> <ul style="list-style-type: none"> 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)
<p>Earth and Environmental Science</p> <ul style="list-style-type: none"> The academic nature and focus on geology will deter some students and limit accessibility. The level of mathematics required will limit the range of students selecting the subject. 	Survey (x1) Submission 1
<p>Physics</p> <ul style="list-style-type: none"> 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 that do not have the talent for senior physics. The Physics subject is aimed at students continuing into Science and engineering. 	Wagga Wagga (FG) 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
<p>All Subjects</p> <ul style="list-style-type: none"> The representation of the general capabilities and cross-curriculum priorities is not authentically embedded and the links to the content are not explicit. There is insufficient time with the amount of content to develop critical and creative thinking. The diminished emphasis on Science Inquiry Skills(SIS) does not align with the stronger intent to develop critical and creative thinking 	<p>Stakeholder (FG), Sydney (FG), Newcastle (FG), Wagga Wagga (FG), DEC DEC, Submission 2</p> <p>Stakeholder (FG), DEC</p>
<ul style="list-style-type: none"> There are some general capabilities that are more evident than others however these still require strengthening to make them explicit in the content e.g. literacy, numeracy and ICT. Sustainability in the science subjects should relate to some key issues about security of food production. 	<p>Stakeholder (FG), Sydney (FG), Newcastle (FG)</p> <p>AIA</p>
<p>Biology</p> <ul style="list-style-type: none"> The general capabilities are not explicitly represented in the content descriptions. 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. The statistics requirements need clarification in the description of numeracy and should be explicit in the content. 	<p>Sydney (FG), Newcastle (FG), Biology (FG)</p> <p>Submission 2</p> <p>Biology (FG), Submission 2</p>
<p>Chemistry</p> <ul style="list-style-type: none"> There is evidence of sustainability but the other cross-curriculum priorities areas are not evident in the content. The scope of ethical understanding needs to be broadened and strengthened in the content. The amount of curriculum content does not provide time for teachers to engage students in critical and creative thinking. 	<p>Stakeholder (FG), Newcastle (FG), Sydney (FG), DEC Chemistry (FG), Submission 8</p> <p>DEC</p>
<p>Earth and Environmental Science</p> <ul style="list-style-type: none"> The only cross-curriculum priority that is explicitly represented in the content is sustainability. Aboriginal and Torres Strait Islander histories and culture is lacking in the content. 	<p>Sydney (FG), EES (FG)</p> <p>Submission 1</p>

Summary of feedback	Source/s
<p>Physics</p> <ul style="list-style-type: none">• The cross-curriculum areas are not clearly evident in the curriculum content.• The scope of ethical understanding should be broader and 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.	<p>Wagga Wagga (FG), Physics (FG)</p> <p>Newcastle (FG), Wagga Wagga (FG), Physics (FG), STANSW, Survey (x1), Submission 5</p>