National Curriculum Board

Framing Paper Consultation Report: The Sciences

May 2009

CONTENTS

1. Introduction

The National Curriculum Board has been charged with developing a single, world-class national curriculum for all Australian students from kindergarten to Year 12, starting with the key learning areas of English, mathematics, the sciences and history.

On 20 November 2008, the National Curriculum Board released for public consultation the set of curriculum framing papers for English, mathematics, the sciences and history. The consultation period officially closed on 28 February 2008. The purpose of the consultation was to obtain feedback from stakeholders that would inform the rewriting of the framing papers to the point where they would be foundational documents for writing the national curriculum.

The framing papers were developed from advice obtained through an extensive consultation process involving national forums, guidance from individual experts and focus groups, input from teachers and academics, and direct feedback through the Board's website.

This report provides a brief description of the consultation process, the process of data analysis, and a summary of the analysis of all feedback received. The summary outlines affirmations for the directions in the framing papers and matters requiring further examination.

The summary is representative of more than 1100 responses, 270 of which were in relation to the sciences Framing Paper. Feedback was received in two forms – via completion of surveys (most through online lodgement) responding to questions asked by the Board, and via formal submissions lodged either electronically or by mail. It represents the contributions of education authorities, professional education associations, individual educators, business and industry, community groups and individuals. The report also provides tabulated data indicating the spread of responses across the many stakeholder groups.

The Board acknowledges with appreciation the contributions of all respondents to the consultation. Many written submissions were extraordinarily detailed, while others provided briefer more indicative input, clearly waiting to contribute further as the curriculum writing process gets under way.

2. Consultation

Process

The National Curriculum Board has committed to an open curriculum development process with substantial consultation with the profession and the public. Stakeholder groups include government, education authorities (national, state and territory, government, Catholic and Independent, and local school authorities where such bodies exist), parent bodies, professional educational associations, academics, business and industry groups, wider community groups and interested individuals from the wider community.

The Board's primary consultation instrument was a survey seeking stakeholder responses to questions posed by the Board in relation to each framing paper. The survey instrument was placed on the Board's website to permit online completion and lodgement. Respondents for whom this was not suitable chose to either mail, email (to the Board's feedback box (feedback@ncb.org.au) or fax the survey responses in to the Board.

Many stakeholders chose to respond by preparing formal submissions. These were received by the Board through mail, email or fax.

All online survey responses and submissions through the Board's electronic feedback mailbox triggered an immediate electronic message of acknowledgment and appreciation for the contribution. All other submissions were responded to individually by staff of the Office of the Board.

Section 5 of this report contains a summary of framing paper survey responses and submissions by respondent group.

The consultation period officially closed on 28 February 2009. At this point in time, the online survey environment was closed. However, significant numbers of responses continued to flow in after that date, and were being entered into the data base as late as the end of March. During March, a gap analysis of major stakeholders was prepared, and direct contact was made with those stakeholders, to ensure that submissions were still forthcoming and would be taken into account in the data analysis process.

In addition to this formal consultation process, a range of consultation forums were held to ensure that specific concerns also within the Board's curriculum development responsibilities are met. These include:

- equity and diversity
- futures-orientation
- stages of schooling
- continua for literacy, numeracy and ICT
- needs of Indigenous children and incorporation of Indigenous perspectives
- Asia-literacy and
- sustainability.

Data Analysis

Upon receipt, every submission and survey response was formally recorded. Those not received through the online process were either scanned (in the case of submissions) or entered manually into the database. A single record of the details of all responses was updated as they were received and weekly summary reports prepared.

Every submission was read by relevant Board staff, and a summary of significant points in each submission was noted for consideration in the collation and analysis of the data. At the same time, the full text of all submissions was recorded for analysis.

The outcomes of the data analysis have been documented in two main forms – feedback that affirms the directions (broad and specific) of the individual framing papers, and feedback that indicates matters that require further examination. In the latter case, additional processes have been put in place to conduct that further examination.

From the data analysis, major affirmations and major areas for examination have been identified in the report. These have been identified both by the strength and frequency of their presence in the responses. Minority insights from individuals or groups of respondents were respectfully taken into account but may not necessarily appear in the report. This does not indicate a rejection of their value as contributions, but recognition of the major directions and concerns emanating from the larger body of data.

3. Feedback affirming the directions in the Sciences Framing Paper

The quantitative data, provided in the table below, indicates a strong level of support for the Sciences framing paper as a whole.

Question	Strongly Disagree	Disagree	Agree	Strongly Agree
Question 2: To what extent do you agree with the aims of the proposed national science curriculum?	5%	9%	43%	43%
Question 4: To what extent do you agree with the definitions and applications of the terms used in this paper?	5%	15%	48%	32%
Question 7: This paper outlines three key elements: Science understanding, Science inquiry skills, and Science as a human endeavour. To what extent do you agree with these elements?	3%	9%	45%	43%
Question 9: The proposed structure identifies the curriculum focus, sources of science understanding and the relevant big ideas of science for each stage of schooling. To what extent do you agree with using these headings as organisers for the curriculum?	8%	24%	47%	21%
Question 11: To what extent do you agree with this approach to organising the science content for Stage 1?	9%	9%	55%	27%
Question 13: To what extent do you agree with the approach to organising the science content for Stage 2?	6%	15%	55%	24%
Question 15: To what extent do you agree with the approach to organising the science content for Stage 3?	4%	20%	47%	29%
Question 19: This section outlines approaches to pedagogy as they apply to the content of a national science curriculum. To what extent do you agree?	4%	8%	45%	43%
Question 21: This section outlines approaches to assessment as they apply to the content of a national science curriculum. To what extent do you agree?	2%	11%	53%	34%

Particular areas of support have been noted below about each aspect of the framing paper.

- There was wide support for the broad scope and direction of the framing paper.
- There was support for the use of 'big ideas' to help frame the curriculum with the suggestion that these need to be linked from stage to stage to support a common use of language, and to clearly link to the listed concepts and topics proposed for study.
- There was strong support for the three elements on which the curriculum should be based (science understanding, science inquiry skills and science as a human endeavour).
- Many respondents supported the paper's assertion that science is a rapidly increasing body of knowledge and there is a need to avoid overloading the curriculum.

- Most respondents supported the inclusion and use of contemporary contexts to which students can relate. It was also considered that:
  - The use of contemporary contexts should be used across the stages of schooling, not only in Stage 3 where the idea is currently most strongly articulated.
  - Particular examples of contemporary contexts should remain as suggestions, rather than mandated.
  - Contexts, including contemporary contexts, should not be restricted to 'what is in students' backyards' but should include local, state, national and international scenarios to achieve relevance.

- There was general support for the statements about pedagogy and assessment in the framing paper.

- In relation to the statement that there needs to be more emphasis on student engagement and inquiry and less on teacher transmission, it was considered that:
  - The curriculum should not dictate any particular pedagogy.
  - A variety of effective pedagogies need to be employed to ensure that science education reflects accurate scientific thought and practice with schools able to select approaches that suit their ethos, values or philosophy.

- The reference to the 'backwards design process' (Wiggins and McTighe: 2005) was supported. Respondents suggested that:
  - Greater emphasis could be included about the various purposes of assessment such as assessment for learning (diagnostic assessment), assessment as learning (formative assessment) and assessment of learning (summative assessment).
  - The paper needs to state the importance of assessing all three elements specified in the structure of the curriculum.

4. Feedback requiring further examination

The following matters have been identified as areas requiring further examination:

1.0 Representation and discussion of science, including the Introduction and the aims for learning about science.

1.1 The definition of science needs to be broadened to recognise that science is about asking interesting questions about the world, not only about answering questions about the natural world. Respondents argued that the frequent use of the terms 'natural world' and 'natural phenomena' were ambiguous and problematic and could be interpreted as precluding relevance to the contemporary designed world.

1.2 There was concern that the science worldview, the beliefs that underpin the work of scientists, was not recognised and it was considered that this could be reflected in the science inquiry skills element.

1.3 The specification of the time period, 'the past two hundred years', in the Introduction was regarded to have the potential to be offensive to Indigenous Australians who have used inquiry processes over many thousands of years. The identification of specific scientists in the introduction was questioned for the lack of female examples and the inclusion of particular Nobel Laureates was considered to have the potential to diminish the importance and value of contributions made by other scientists. While the emphasis on Australian science was appreciated, there was also thought that the global perspective and global citizenship were significant inclusions to be made.

1.4 Respondents considered that economic and political imperatives for learning about science dominated discussion of the introduction and the aims, and took precedence over students' entitlement to learn about science in order to develop their capacity to become scientifically literate, active citizens. The dominant economic and political arguments were seen to conflict with the framing paper's assertion that science should embody a 'science for life' approach.

1.5 Respondents queried the singular reference to the UK Ofsted report (2008) recommending a commitment to science inquiry. There were calls for the example to be deleted or for it to be accompanied by further research and /or by inclusion of Australian examples, for example research into the Primary Connections: linking science with literacy program.

1.6 There were different views about the inclusion, or absence, of the affective domain including values in the sciences. Some respondents argued that the paper was deficient in its lack of addressing the affective domain, whilst others considered too much emphasis on active citizenship and social outcomes to the detriment of focussed discussion of scientific knowledge and skills. There were comments that the broad focus of the curriculum needed to be 'science for citizenship' and much less about 'future scientists'.

1.7 The absence of reference to sustainability/environmental science was noted and considered that due to its importance in contemporary science, it should be named explicitly as a key driver in the context of science education.

1.8 Respondents called for the aims of learning to be explicitly stated as aims with supporting objectives – currently seen as a mix of the two. Respondents also called for the issue of ethics and the need for ethical decision making to be included within the aims section. Concern was noted about the absence of clear recognition and articulation about the need in science education to harness and build on students' interest and enthusiasm.

1.9 There was support for the paper's assertion that while school science should prepare students for active citizenship, it should also provide a foundation for more specific pathways. There was discussion relating to the adequacy of the aims in dealing with the range of scientific knowledge required for a technological society and a call for the broad profile of technological capability required for the 21st century to be recognised and explained.

2.0 Terms used in the paper, particularly science capabilities.

2.1 Much comment was made about the use of the term *science capabilities* as a replacement for the term *scientific literacy/ies:*

2.1.1 The majority of respondents who commented on this issue advocated for the term scientific literacy/ies to be used rather than the term science capabilities due to its currency of use and meaning including in the science community, its international understanding and use and the work already done with Australian education systems and teachers to develop understanding and use of the term.

2.1.2 Most respondents considered that the term science capabilities was not well understood and that the term should not be considered as a direct substitute for scientific literacy which was considered to have broader intent than the term science capabilities as defined in the framing paper.

2.1.3 The paper's assertion that the term scientific literacy sometimes caused confusion in the broader community, and that this was a valid reason for creating a new term, was challenged by many respondents including significant educational agencies and professional associations and considered unacceptable.

2.1.4 It was considered that a departure from the term scientific literacy will damage the progress and momentum occurring in the teaching of science in primary schools, including the progress associated with *Primary Connections.*

2.2 Respondents considered that broader, deeper definitions of the term *technology* should be provided:

2.2.1 The definition needs to contain a clear description of technology, rather than just stating its benefits.

2.2.2 It was considered that the bidirectional dependence of science and technology should be explicitly stated, especially considering the dependence of modern technologies on advances in science complemented by advances in science which have occurred because of advances in technology.

2.2.3 Use should be specific and consistent, for example the alternating use of the terms 'technology' and 'technologies' throughout the document might cause confusion for teachers. In some jurisdictions, the term 'technologies' refer to specific technological areas such as Information and Communication Technologies, (ICTs). In some jurisdictions, 'technology' is an abridged term for technology education which involves the processes of designing and producing in the contexts of products, information and communication, and the built environment.

2.2.4 There was call for the term 'engineering' to be included as a discrete stand-alone term considering it is more appropriate than the term 'technology', and that is should be understood alongside, and in contrast to, science and technology.

2.3 Respondents considered that broader, deeper definition of the term contemporary science should be provided:

2.3.1 The definition should identify what is considered contemporary science, for example 'new and emerging scientific research' and/or issues of contemporary relevance.

2.4 There was call for references to science and scientists to be broadened to increase inclusivity, for example including reference to 'study of science based disciplines', rather than just 'science' and including references to 'future scientists, engineers and technologists'.

3.0 Determining and representing the nature of the big ideas.

3.1 While there was support for the use of big ideas to frame the curriculum, there was a deal of discussion about what constituted these big ideas. There were comments that the 'relevant big ideas of science' were not really the big ideas of science, rather they were a mix of 'big ideas for learning science', 'science processes' and 'some big ideas of science'.

Respondents considered it important that the 'big' (or unifying) ideas be separated from science processes and be well described, including identifying what is unique to science about the ideas. It will also be important for a clear determination about how the big ideas are intended to be used to be made to ensure alignment between the learning focus, the learning activities and assessment.

3.2 Many respondents considered the relevant big ideas need to be included across the K-12 curriculum with obvious links between the stages of schooling to show how the ideas are being developed. Further critical analysis of the proposed structure for the K-12 science curriculum is needed.

3.3 There was call for the implications resulting from omitting 'content strands' or other explicit organising frameworks of science concepts to be reconsidered, including the recognition of consequences for teacher professional learning that will result from the use of a new model.

3.4 The proposed structure (Table 1, p. 6) was widely misinterpreted. Respondents considered the table to be 'too busy' with the key elements lacking inclusion/emphasis and the inclusion of 'source of interesting questions' queried. A clear articulation of the three elements in the proposed structure of the curriculum was not seen to be provided in Table 1, nor in the elaborations of each stage provided in the latter part of the framing paper.

3.5 Respondents queried the introduction of the headings in Table 1 which introduced a different set of organisers and which had not been described prior to their appearance in the section titled 'Structure of the curriculum'.

4.0 Embedding the three elements across the curriculum.

4.1 While there was support for the three elements used to structure the curriculum, many respondents called for all three to be clearly articulated in each of the stages.

4.2 Respondents considered that science inquiry skills should be included in the curriculum in a systematic way, noting that it is important that development of skills across the K-12 curriculum is clearly articulated (progression is not about an ongoing introduction of more skills but the sophistication of skills changes as students develop).

It was considered important that the science inquiry skills would align with the National Scientific Literacy Progress Map (MCEETYA, 2006).

4.3 Science as a human endeavour was seen as an integral element to enable students to realise the importance of people in science inquiry and as a way to authenticate science and make it relevant to students' lives.

It was recommended that the element 'science as a human endeavour' be explicitly addressed in the structure, organisation and content for each stage, rather than embedding it (or expecting teachers to) within the development of conceptual understanding.

5.0 Representation of the science curriculum across the stages of schooling.

5.1 Respondents called for 'topics and major concepts' within the descriptions for each stage to be separated and to be clearly linked to the relevant big ideas. There was also the suggestion that the term 'topic' could be replaced with 'area for investigation'.

5.2 Further discussion about the use of the term 'topic' noted that the conceptual understanding to be developed through a topic needed clear description to support deep conceptual development. It was also noted that topics themselves were not year level/age specific but that the conceptual understanding underpinning the topic needs describing.

5.3 In relation to primary schooling, there was some thought that 'considerations' noted in the paper were not specifically relevant for primary school. In particular the section discussing 'selection of science content' was seen to focus on the issue of reforming secondary education without taking into account the need to establish a clear and explicit science curriculum for primary schools. While the section discussing 'relevance of science learning' was supported, the problem identified for primary schools was more to do with the absence of science being taught rather than with the relevance of what is being taught.

5.4 The issue of overlap into a geography curriculum was flagged as needing to be considered as part of the next stage of science curriculum design. Aspects such as weather, water and the management of water, climate change and earth sciences (plate tectonics) have traditionally been part of the geography learning area.

5.5 **Stage 1:** While respondents considered the inclusion of play and emphasis on observational skills was important, it was also suggested that this stage lacked relevant and appropriate content that could be explored and observed. The approach in general was supported, particularly moving from the immediate environment to broader understandings.

The 'relevant big ideas of science' were seen to be skills rather than 'big ideas' with calls for greater scope in content to be recommended for this stage.

5.6 **Stage 2:** It was considered that Stage 2 contained too many topics and major concepts (too much content). There was a suggestion that the content that is listed could be clustered together to illustrate major concepts, reducing the amount of content.

It was suggested that Stage 1 and Stage 2 could include a further guide about what concepts (content and topics) should be introduced when and in what sequence.

5.7 **Stage 3:** Many respondents called for consistent language use across the stages of schooling, particularly in Stage 3 and Stage 4 (while maintaining an integrated approach to the study of science in Stage 3). The use of terms physical sciences, biological sciences and earth and space science in Stage 3 being followed by Stage 4 terms physics, chemistry and biology was seen as disjointed. Continuity of language was seen as important to aiding students to identify their interests and strengths.

Respondents sought the inclusion of more specific advice about opportunities for differentiating the curriculum in the latter half of Stage 3.

5.8 **Stage 4:** Respondents considered that the three interrelated elements used to structure the curriculum provided an effective basis for consistent application throughout the proposed curriculum. It was suggested that the absence of discussion relating to elements of science inquiry skills and science as a human endeavour in Stage 4 implies, falsely, that these are no longer as important as the content (science understanding).

5.9 Some respondents sought clarity on whether all students will be expected to study the sciences in Stage 4.

5.10 **Stage 4 (senior secondary courses):** The inclusion of environmental science as a senior secondary course was not supported with the majority of respondents considering that earth and environmental sciences is a preferable course for inclusion in the national curriculum. The inclusion of earth sciences across the stages of learning and across all senior secondary courses was also raised, as was the issue of the potential for environmental science to overlap significantly with geography. It was considered that an earth and environmental science course could be considered as an interdisciplinary course.

5.11 While there was some support for an additional, interdisciplinary course, respondents flagged issues of equity (for example, making sure the course is not seen as less rigorous or for less able students which would diminish its value) and for such a course to be developed in consultation with industry to ensure currency of content, scientific practice and direction. The importance of the 'power of perception' in driving choice and take-up of courses was raised as an matter for consideration in relation to such a course.

5.12 There was strong support for existing courses across the states (for example, Human Biology, Agricultural Science and Psychology) to be retained as specialised courses. It was suggested that a rigorous framework be developed through which other, more specialised course, could be 'accredited'.

6.0 The inclusion of literacy and numeracy in the context of learning of, and about, science.

6.1 Respondents considered that literacy and numeracy were key components of science curriculum and that they needed to be dealt with explicitly in the science curriculum.

6.2 It was considered that literacy should not just be referenced as a cross-curriculum skill but rather as a foundational skill needed to access the discipline of science.

6.3 Respondents noted that links with literacy and numeracy were important across the years of schooling, with particular emphasis given to the importance and value of science in the primary school setting as a context and opportunity for integration with other learning areas especially literacy and numeracy.

7.0 The representation and inclusion of technology.

7.1 In addition to calls for the definition of technology in the defined terms of the paper to be reviewed, there were calls for the inclusion of technology and/or technological applications to be included in the curriculum structure at all stages.

8.0 The representation and inclusion of Indigenous Australian perspectives in teaching and learning science.

8.1 It was considered that the framing paper needed to acknowledge Indigenous Australian knowledge and learning systems as distinct entities with unique value and integrity, and with the ability to inform Australian responses to key contemporary challenges such as land management and climate change.

8.2 There was also comment that the framing paper did not include reference to the issue of Indigenous student learning in science including the achievement gaps apparent between non-Indigenous and Indigenous students in national and international assessments, nor to ways this gap could be addressed.

Other considerations

The following considerations have been identified related to implementation. These are outside the remit of the Board but are included for noting.

- Implications of major system change – the level of preparedness of teachers to manage the approach proposed in the framing paper to move from a transmission model teaching of discipline abstractions to a model with a greater emphasis on student engagement and inquiry was raised as a risk for the successful implementation of the national curriculum for the sciences. The importance of recognising the potential impact and implications of proposed changes and planning for the professional development of science teachers was considered integral to the success of the project.

- Teacher training (pre-service and in-service) – availability of qualified teachers of science; teachers' understanding of science concepts (especially for primary teachers); ongoing professional development including maintaining currency with changing knowledge and emerging contexts; support for teachers teaching outside their area of expertise; pedagogical tools to adjust to inquiry focussed approach.

- Recommended teaching time – some respondents called for the framing paper for the science curriculum to recommend, if not mandate, sufficient and minimum time allocations to the teaching of science at various stages of schooling.

- Available resources – support materials; quality resources (eg texts); specialist teachers in primary school setting; resourcing of science classrooms and laboratories with equipment and technical staff.

  Respondents flagged the Australian Government funded, Australian Academy of Science managed program Primary Connections: linking science with literacy as an example of an exemplary model for professional learning and curriculum resources in the primary school setting from which important learning could be taken.

- Incorporation of digital technologies to support learning and assessment.

- Timing of, and support for, implementation.

5. Addressing feedback requiring further examination

The table that follows identifies the actions that have or will take place in response to the key issues that have emerged from the consultation feedback.

No	Item	Source	Action for consideration
1	**Representation and discussion of science, including the Introduction and the aims for learning about science**	Academics Business & industry stakeholders Education authorities Parents Principals Professional associations – principals Professional associations – teachers (state) Professional associations – teachers (national) Teachers Union	**Action 1:** Advice was sought from an expert consultation group on key issues raised through the consultation feedback. Advice and direction was provided for: • revisions to the text in the section Introduction (1.1, 1.2, 1.3, 1.4, 1.5, 1.6 1.7) • revisions to the text in the section Aims (1.8, 1.9) **Action 2:** Specific revisions have been made as follows: • revisions made to the Introduction (1.1, 1.2, 1.3, 1.4, 1.5, 1.6 1.7) • revisions to text made in the section Aims (1.1, 1.9) **Action 3:** Specific instructions will be provided to the Sciences advisory panel and curriculum writers on the following matters: • articulating and describing the supporting objectives for learning science within the aims for the science curriculum as a whole (1.8)

No	Item	Source	Action for consideration
2	**Terms used in the paper, particularly science capabilities**	Academics Business & industry stakeholders Education authorities Principals Professional association – principals Professional associations – teachers (state) Professional associations – teachers (national) Teachers Union	**Action 1:** Advice was sought from an expert consultation group on key issues raised through the consultation feedback. Advice and direction was provided for: • the use of the terms 'science capabilities' and 'scientific literacy/ies' (2.1) • revised definitions and use of the terms 'technology' and 'contemporary science' (2.2, 2.3, 2.4) **Action 2:** Specific revisions have been made as follows: • the revised version of the paper does not define or use either term 'science capabilities' and 'scientific literacy/ies' (2.1) • revisions to the definition of 'technology' and 'contemporary science' made in revised Sciences Framing Paper (2.2, 2.3, 2.4) **Action 3:** Specific instructions will be provided to the Sciences advisory panel and curriculum writers on the following matters: • incorporating and exemplifying the use of contemporary contexts for learning science (2.2, 2.3, 2.4)

No	Item	Source	Action for consideration
3	**Determining and representing the nature of the big ideas**	Academics Business & industry stakeholders Education authorities Principals Professional associations – principals Professional associations – teachers (state) Professional associations – teachers (national) Teachers Union	**Action 1:** Advice was sought from an expert consultation group on key issues raised through the consultation feedback. Advice and direction was provided for: • development of a refined curriculum design for K-12 that represents the big ideas in a developmentally appropriate manner embedded within contemporary contexts for learning (3.1) • representing the nature of the big ideas including demonstrating development and links across the K-12 curriculum for science, including the three elements of the curriculum (3.2, 3.4, 3.5) **Action 2:** Specific revisions have been made as follows: • proposed structure (Table 1, p.6) removed from framing paper (3.4, 3.5) • revision to the use of the term 'big idea' to 'unifying idea' (3.4, 3.5) • revision to the outline of the science curriculum from K-10 to clarify the relationship between the strands and the unifying ideas, formerly the 'big ideas'. **Action 3:** Specific instructions will be provided to the Sciences advisory panel and curriculum writers on the following matters: • consideration and implementation of a necessary and sufficient set of scientific theories and a set of contemporary contexts for learning science. **For noting:** • consideration and monitoring by advisory panel and jurisdictions of potential implementation issues that may arise from a final curriculum structure, including the recognition of consequences for teacher professional learning (3.3)

No	Item	Source	Action for consideration
4	**Embedding the three elements across the curriculum**	Academics Business & industry stakeholders Education authorities Parents Principals Professional associations – principals Professional associations – teachers (state) Professional associations – teachers (national) Teachers Unions	**Action 1:** Advice was sought from an expert consultation group on key issues raised through the consultation feedback. Advice and direction was provided for: • development of a refined curriculum design for K-12 that embeds the elements of science inquiry skills and science as a human endeavour within the curriculum (4.1, 4.2, 4.3) **Action 2:** Specific revisions have been made as follows: • additional text has been included to represent the strand of science as a human endeavour across the curriculum (4.1, 4.3) • revision to the strand of science inquiry skills in line with the National Scientific Literacy Progress Map (MCEETYA, 2006) (4.1, 4.2) **Action 3:** Specific instructions will be provided to the Sciences advisory panel and curriculum writers on the following matters: • further aligning the science inquiry skills of the national sciences curriculum with the National Scientific Literacy Progress Map (MCEETYA, 2006) (4.1, 4.2)

No	Item	Source	Action for consideration
5	**Representation of the science curriculum across the stages of schooling**	Academics Business & industry stakeholders Education authorities Parents Principals Professional associations – principals Professional associations – teachers (state) Professional associations – teachers (national) Teachers Undergraduate teacher Unions	**Action 1:** Advice was sought from an expert consultation group on key issues raised through the consultation feedback. Advice and direction was provided for: • development of a refined curriculum design for K – 12 that represents the big ideas in a developmentally appropriate manner embedded within contemporary contexts for learning (5.2, 5.3, 5.5, 5.6, 5.7, 5.9, 5.10) **Action 2:** Specific revisions have been made as follows: • revisions to the use of terms 'topics and major concepts' (5.1, 5.2) • revisions to the representation of the curriculum across the stages of schooling, including the relevant unifying ideas of science (formerly the 'big ideas') (5.2, 5.3, 5.5, 5.6, 5.7, 5.9, 5.10) • revisions to the science understanding strand (formerly 'topics and major concepts') included across the K-12 curriculum for the sciences (5.3, 5.5, 5.6, 5.7) • revisions to the senior secondary courses included (5.8, 5.10) **For noting:** • Consultative and collaborative relationship to be established in the writing of the sciences and the geography curriculums (5.4) • Issues for implementation to be considered: possibility of mandating of science study in senior years; existing state and territory courses to be retained as specialist courses (5.9, 5.12)

No	Item	Source	Action for consideration
6	**The inclusion of literacy and numeracy in the context of learning of, and about, science**	Academics Business & industry stakeholders Education authorities Professional association – principals Professional association – teachers (national)	**Action 1:** Advice was sought from a Literacy and Numeracy Forum to develop definitions and writing instructions for literacy and numeracy across the learning areas. Advice was sought from an expert consultation group on key issues raised through the consultation feedback. Advice and direction was provided for: • inclusion of literacy and numeracy within learning area curriculum (6.1, 6.2, 6.3) **Action 2:** Specific revisions have been made as follows: • additional text has been included to address literacy (English) and numeracy (Maths) and connections to other learning areas (6.1, 6.2, 6.3) **Action 3:** Specific instructions will be provided to the Sciences advisory panel and curriculum writers on the following matters: • effective inclusion of literacy and numeracy in the science curriculum (6.1, 6.2, 6.3)

No	Item	Source	Action for consideration
7	**The representation and inclusion of technology**	Business & industry stakeholders Education authorities Professional associations – teachers (state) Teachers	**Action 1:** Advice was sought from an expert consultation group on key issues raised through the consultation feedback. Advice and direction was provided for: • Revised definition and inclusion of technology (7.1) **Action 2:** Specific revisions have been made as follows: • Revisions to the definition of technology made in revised Sciences Framing Paper (7.1) **Action 3:** Specific instructions will be provided to the Sciences advisory panel and curriculum writers on the following matters: • incorporating and exemplifying the application and use of technology through relevant contemporary contexts for learning science

No	Item	Source	Action for consideration
8	**The representation and inclusion of Indigenous Australian perspectives in teaching and learning science**	Academics Business & industry stakeholder Education authorities Professional association – teachers (national)	**Action 1:** Specific revisions have been made as follows: • acknowledgement of Indigenous Australian perspectives (8.1) **Action 2:** Specific instructions will be provided to the Sciences advisory panel and curriculum writers on the following matters: • inclusion of Indigenous Australian perspectives as a cross curriculum perspective (8.1) **For noting:** • consideration and monitoring by jurisdictions of Indigenous student achievement in learning, including in learning science (8.2)

6. Summary of submissions

The National English Curriculum: Framing Paper

Consultation period: October 2008 – February 2009

Data as at 27 March 2009

Submissions	
English	87
Mathematics	67
Science	78
History	82
	314
Surveys	
English	246
Mathematics	159
Science	192
History	220
	817
Total of all feedback	
English	333
Mathematics	226
Science	270
History	302
	1131

7. Appendix: What the community said in response to NCB survey questions

Introduction

Question 1: Please comment on the Introduction.

While there was some support for the Introduction, much feedback was provided about the Introduction with a number of matters raised including the definition of science, the inclusion of examples of Australian scientists, the singular reference to the UK Ofsted (2008) report and the perceived dominance of economic and political imperatives for learning about science (see Areas for further examination (1) for further information).

- *The introduction provides a reasonable description of the purpose of science and the importance of being able to engage in scientific discussion and to be questioning of the scientific claims made in the media.*

  Paragraph 13 identifies a small number of Australians, in particular Nobel Laureates that have made a contribution to science. Unfortunately this has the potential to diminish the importance and value of outstanding contributions made by many scientists in this country. (Education authority)

- *We question the definition of Science as "a way of answering questions about the natural world". This implies that Science is confined to things or issues that are "natural" and not to things that are mechanical or of human construction. "Natural world" is likely to invoke interpretations based on "the environment". This seems to suggest that things that are not "natural" (things that are mechanical or of human construction, or are from beyond earth) are not a part of Science. We suggest that this is reworded to reflect a broader view of what Science is.* (Professional association)

- *The reference in the opening sentence and similar expressions elsewhere on "the natural world" is ambiguous and problematic. If "natural" is intended to be interpreted as excluding "constructed" or "designed" (this term is used in the Table on page 10), the scope of meaning denies the great body of scientific inquiry concerned with human-constructed materials and systems, including human organisations.* (Business or industry)

- *Generally good. Outlining the background of development is essential for understanding the proposed document.* (Educational professional – teacher)

Aims

Question 2: To what extent to you agree with the aims of the proposed national science curriculum?

Strongly Disagree	Disagree	Agree	Strongly Agree
5%	9%	43%	43%

Question 3: Please comment on the aims of the proposed national science curriculum.

The proposed aims were endorsed by the respondents. There was concern articulated in regard to the capacity of the aims to provide for the range of scientific knowledge required in a technological society and the absence of clear recognition about the need to harness students' interest and enthusiasm.

- *The aims of the national science curriculum need to be succinct. The document currently presents too many different expectations of the curriculum. The aims are adequately captured in paragraph 18.*

  The current aims emphasise the role of science education as preparing students to be active citizens (paragraph 19) and providing a foundation for specific science pathways. A well developed national science curriculum should achieve this. There is pressure on the national science curriculum to meet the opposing demands of science for all, creating scientifically-capable citizens and on generating more 'scientists' by encouraging students to pursue post-compulsory science-related studies.

  The national science curriculum should focus on the development of scientifically capable citizens who have been engaged and excited by their science education. If this occurs students should see sufficient value, purpose and opportunity in science to consider post-graduate study in the field and possibly a career in science and science related fields. (Education authority)

- *Interest in and understanding of the natural world is again treated simply as an outcome. The list of Aims is highly utilitarian – an approach that has little appeal to the majority of students who experience little of use from their science learning in school unless its content and details are intrinsically appealing to them.* (Academic)

- *The aims of the science curriculum do not deal adequately with the profile of scientific knowledge required by a technological society. As observed above this project will have a major influence on Australia's science technology and engineering future and in our opinion it is insufficient to detail a baseline in scientific literacy, as the paper does in clause 18, but beyond that make only a distant gesture towards a broader remit as in clause 19. The curriculum can quite reasonably argue science literacy for the many and discovery research for the few but needs to say much more about what comes in between.*

  A framework document should articulate in broad terms the profile of technological capability required of a 21st century society and explain how the curriculum will address it. In the current epoch those who want to encourage students into, for example, engineering, environmental management, bio-business, pathology, quality assurance, etc, etc, not to mention research science, should have far more compelling support from a national curriculum in science and mathematics.
  (Business or industry stakeholder)

- *A little concerned that the political process found the need to make the jingoistic statements in the final aim, but I am supportive of the concepts expressed.* (Educational professional – teacher)

Terms used in this paper

Question 4: To what extent to you agree with the definition and application of the terms used in this paper?

Strongly Disagree	Disagree	Agree	Strongly Agree
5%	15%	48%	32%

Question 5: Please comment.

Much comment was made about the use of the term *science capabilities* as a replacement for the term *scientific literacy/ies*, and there were also calls for broader, deeper definitions of technology and contemporary science.

- *The professional associations that represent the Science education community of Australia must take issue in the strongest possible terms with the abandonment of the notion of "Scientific Literacy" in favour of the term "science capabilities". We do not accept the claim expressed in this paragraph that "science capabilities" is to be preferred because it is "commonly understood", whereas "scientific literacy" causes confusion.*

  These claims are far from correct. To our members these terms are far from being interchangeable. Feedback suggests that whilst "scientific literacy" is very well understood as a broad overarching understanding of critical scientific principles and processes, the term "science capabilities" implies a somewhat lower order checklist of individual skills, the sort of things you can tick a box against. (Professional association)

- *Generally, the terms used are appropriate and adequately justified in the framing paper. However the loss of 'scientific literacy' in favour of 'scientific capabilities' is not supported... 'Capability' is not the same thing as 'literacy' and given that the term 'literacy' is broadly used and widely recognised within existing science programs, including Primary Connections, the arguments for using 'capabilities' are not adequately justified in the framing paper.*

  There should also be consideration given to the use of the term 'technology'. It is critically important for students to recognise the range of career pathways open to them. While we have embraced the acronym STEM and SET it does seem that the definition of 'technology' in the framing paper refers to the use of scientific knowledge in the profession of engineering, although this is not explicit.

  Members of our organisation have commented that in many instances the use of the term 'engineering' is far more appropriate than the use of the term 'technology'. Members are particularly concerned that the use of the term 'technology' is often misleading and confusing. (Business or industry stakeholder)

- *The framing paper emphasises the importance of a contemporary science focus in the national science curriculum. The term used currently fails to identify what will be considered as contemporary. It also poses a risk to the future relevance or currency of the national science curriculum. If we specify contemporary issues to be addressed in the syllabus there will need to be continual review and revision of the stated current contemporary issues as these will quickly become historical fact.* (Education authority)

- *Science capabilities suggest skills. Scientific literacies suggest a much greater depth of understanding.* (Educational professional – teacher)

Considerations

Question 6: Comment on the considerations that need to be taken into account when developing national science curriculum. Are there other considerations not canvassed in the paper?

Considerations raised included the representation and inclusion of Indigenous Australian perspectives in teaching and learning science, and the inclusion of literacy and numeracy in the context of learning of, and about, science. Respondents also provided feedback on issues such as recommending or mandating sufficient time to the teaching of science, the implications of major system change and consequences for teacher training and professional learning and other resourcing needs.

- *The framing document must acknowledge Aboriginal and Torres Strait Islander Peoples' Knowledge and Learning Systems as distinct entities with unique value and integrity, and give status to these as our sole means of engaging with Australia's extra-colonial heritage of scientific and environmental knowledge. This is particularly important as Aboriginal culture has immense potential to inform Australian responses to land management, natural resource and climate challenges.*

  A word search indicated there were no references to 'Aboriginal', 'Torres Strait Islander', 'Indigenous', 'First Nation' in the framing paper.

  The framing document and curriculum need to be consistent with COAG Agendas, MCEETYA Australian Directions in Indigenous Education and the Melbourne Declaration on Educational Goals for Young Australians for Aboriginal and Torres Strait Islander young people.

  The Board and Advisory Groups should consider best-practice from other countries, such as the status of the Maori People in New Zealand Curriculum documents and First Nations Peoples in Canadian Curriculum documents. (Education authority)

- T*o simply implant a curriculum that embodies a new teaching philosophy into a system geared towards an old one runs a very high risk of failure. The national curriculum proposes to move away from transmission model teaching of discipline abstractions and instead support (in our view, guided) student centred learning, revealing the disciplines through their power to solve problems and enlighten students about their world.*

  One great danger in this approach lies in the level of preparedness of teachers. It is now widely recognised that there is a teacher shortage in science and mathematics, and that teachers outside these disciplines are increasingly called upon to teach them. However, to identify and teach to the relationship between student interests and particular discipline knowledge requires far greater discipline expertise than the transmission model. In theory such an approach to curriculum should deliver superior educational outcomes. In practice, in an education system not prepared for it, it may well deliver poorer outcomes, with real science, as embodied in physics, chemistry, mathematics and biology, downgraded.

  Teaching in a way that responds to student interests and the current issues of their world also requires a different professional environment for teachers. In particular, they would need structured time and accountability for professional development and participation in professional networks that allowed them the means to reflect upon and research these issues. At present such time is not part of the teacher's working life. (Business or industry stakeholder)

- *It is also necessary to know the time that is to be allocated to a course before the curriculum can be developed as this will determine the breadth and depth of the elements that can be realistically covered. The National Science Curriculum must be able to be learned by most students in the recommended time frame. The curriculum must allow flexibility so that local contexts can be used to enhance its relevance.* (Professional association)

Structure of the curriculum

Question 7: The paper outlines three elements: Science understanding, Science inquiry skills and Science as a human endeavour. To what extent to you agree with these elements as the basis for the national science curriculum?

Strongly Disagree	Disagree	Agree	Strongly Agree
3%	9%	45%	43%

Question 8: Please comment.

While there was support for the three elements used to structure the curriculum, many respondents called for all three to be clearly articulated in each of the stages.

- *These elements should underpin the development of the National Science Curriculum K-12. There is not a clear articulation of these three elements in the proposed structure of the curriculum provided in Table 1, nor in the elaborations of each stage provided in the latter part of the framing paper. The elements appear to have been lost in trying to propose topics and content which should be the role of the curriculum writers not of the framing paper.* (Education authority)

- *The element of Science as a Human Endeavour has to be explicit and not implicit. It is arguably the most important of the three elements, and experience tells us that which is not explicitly stated, and assessable, will not be taught (as effectively). If we value it, it must be stated and assessed for.* (Education authority)

- *The three inter-related elements identified in the Framing paper to describe school science will provide a balanced approach to the nature of science in the curriculum.* (Business or industry stakeholder)

- *This aligns perfectly with other curricula based on pedagogical research of best practice – the IBMYP (and probably the other 2 IB programs that I do not teach) and the French 'Common Base of Knowledge and Skills' I am also familiar with – so suggests nationallyAustralia is integrating with world standard best practice.*

  It also sets up requirements for a balance of tasks for students to do – (1) Learning pedagogical content knowledge – these are the symbols with which students eventually need to navigate their (2) experimental approaches/ results and (3) link their literacy based reading / language tasks in context of big picture contemporary ideas. All three of these elements support each other, and this description helps teachers plan units that include a variety of authentic assessment tasks – which will be exciting for teams of teachers to plan and very engaging for students to do. (Educational professional – teacher)

Structure of the curriculum

Question 9: The proposed structure identifies the curriculum focus, sources of science understanding and the relevant big ideas of science for each stage of schooling. To what extent do you agree with using these headings as organisers for the curriculum?

Strongly Disagree	Disagree	Agree	Strongly Agree
8%	24%	47%	21%

Question 10: Please comment.

There was support for the use of 'big ideas' to help frame the curriculum with the suggestion that these need to be linked from stage to stage to support a common use of language, and to clearly link to the listed concepts and topics proposed for study. Respondents also provided feedback about the nature and description of the 'big ideas'.

- *'Relevant big ideas' is an important element of any science curriculum. These are not clear articulated and some of the descriptions would not be considered by teachers as being big ideas in science. They are more likely to be described by teachers as possible contexts for learning.* (Education authority)

- *The writers will need to embed the 'big ideas' in the science domain to give them meaning. What is unique to science about these ideas will need to be identified. While there are a variety of possible ways to describe science, does the meaning of the 'big ideas' lie within the strands/content/conceptual basis of science, an inter-disciplinary approach, the topics, or is it in all three elements – science understanding, science inquiry skills and science as a human endeavour at all levels of schooling?*

  I think it needs a very deep understanding of science to appreciate the 'big ideas'. Teachers in the primary and lower secondary school frequently have a limited science background and will need support to understand and meaningfully use the 'big ideas'. A science conceptual framework is therefore needed…The omission of 'strands' or other organizing frameworks of science concepts is unhelpful and needs reconsideration. (Business or industry stakeholder)

- *We are supportive of the use of the big ideas to help frame the curriculum. However, there are issues that result from the use of these.*

  - *There needs to be a greater linking of the 'big ideas' from stage to stage, with a more common use of language across the stages.*

  - *The 'big ideas' need to be more clearly linked to the listed concepts. In their current form they could add another layer of curriculum design, without great benefit, if coherent links to the concepts are not made. This might limit the benefit of using these overarching ideas.*
    (Professional organisation)

- *The idea of teaching to the 'Big Ideas' is more appropriate than the knowledge heavy approach of old, offering teachers flexibility in the way they present the major science principles to their class and opportunity to set these ideas in a familiar context for students.*
  (Educational professional – teacher aide)

Structure of the curriculum

Question 11: To what extent do you agree with this approach to organising science content for Stage 1?

Strongly Disagree	Disagree	Agree	Strongly Agree
9%	9%	55%	27%

Question 12: Please comment.

While respondents considered the inclusion of play and emphasis on observational skills was important, it was also suggested that this stage lacked relevant and appropriate content that could be explored and observed. The approach in general was supported, particularly moving from the immediate environment to broader understandings.

- *The account of science for Stage 1 is reflective of the general lack of primary schooling in this document. In effect, it fails to outline a science program. A comparison of Stages 1 and 2 reveals that Stage 1 is not taken seriously as an introduction to science…If science is to be established in primary schools, the developers of national curriculum will have to seek advice as to what kind of science is appropriate for children ages 5 – 8.* (Professional association – Principals)

- *Some of the 'topics and major concepts' currently listed in Stage 2 could also be addressed in Stage 1, depending on the learning demand of the concepts chosen. Early childhood Stage 1 seems to underestimate the capacity of young learners if it is to apply to the range 5 to 8 years of age.* (Business or industry stakeholder)

- *There is good general agreement about this section. The following points are noted:*

  - *The third header on the left "Topics and major concepts" might be better termed "Areas for Investigation". In the second row "Science inquiry skills", there should be dot points relating to "developing an explanation" and about "cooperative learning/working together".*

  - *There should be more about the importance of Communication i.e. recording and reporting findings. There are strong Literacy and Numeracy links here.*

  - *There should be the introduction of content at this stage – suggest the big ideas of "Change" and "Patterns" be introduced here as a context though which science inquiry skills can begin to be developed.* (Professional association)

- *I agree with the proposals here and think the curriculum should be integrated up to end of Stage 3.*

  - *Stage 1: The curriculum focus talks about the local natural world…the use of natural is problematic because students arriving at school probably don't distinguish between the made and natural worlds. The world they mostly experience is probably the made world; it takes effort to go out into the natural world. Do teachers ignore the made world or do they explore both and lead students to operational definitions of each world? I think the latter is the better way to go.*

  - *Provide lots of annotated observation statements made by students so that K-6 teachers can see which ones are the bases for a scientific view of the world (colour, shape, size, loud, soft, above, below, hot, cold…about the relational and physical and chemical properties, though not in those terms). If this is not done well, then the basis for the second stage focus will not be there.* (Academic)

Structure of the curriculum

Question 13: To what extent do you agree with this approach to organising science content for Stage 2?

Strongly Disagree	Disagree	Agree	Strongly Agree
6%	15%	55%	24%

Question 14: Please comment.

It was considered that Stage 2 contained too many topics and major concepts (too much content). There was a suggestion that the content that is listed could be clustered together to illustrate major concepts, reducing the amount of content.

- *Stage 2 offers a much more appropriate account of science in the primary yeats. It contains too much content, given the likely time available for teaching science in the priamary years, but the scientific concepts, content and skills are appropriate to children of these ages. The escess of content could be dealt with in part by moving some aspects of some concepts and content to the Stage 1 description.* (Professional association – Principals)

- *Suggest that 'topics and major concepts' listed be reviewed and grouped into fewer topics. For example: plants, animals, planets, space exploration, matter, astronomy and electricity. Science inquiry skills: Higher-order thinking involved in 'analysing data to explain the relationship between different factors' could be too challenging for students in this stage. Suggested to substitute the word explain with 'describe'.* (Education authority)

- *There is strong general agreement with this table. Particular points include:*

  - *Second row "Science inquiry skills" to include a new dot point "recording data".*

  - *The third descriptor "Topics and major concepts": the use of the term "topic" is problematic. This might be better expressed as something like "Relevant important concepts and areas for investigation".*

  - *It will be most important that the Doing of Science (the process) is not overtaken by the Content of Science knowledge in this section.*

  - *What is missing?*

  - *Integration with other Learning Areas, particularly in the Primary years. The successful teaching of Science in a Primary context, in most situations, relies heavily on this integration. We know from experience that where Science in a Primary setting is presented as a standalone curriculum that does not directly link to the other learning areas it is frequently given very little attention and done badly if at all. We think that it will be important for the curriculum writers to specifically draw out the many opportunities for linking to the other areas of learning, and particularly to literacy and numeracy.* (Professional association)

- *Like the future focus. Easily fits with cross-disciplinary thinking. Relevant and wide ranging topics. Topics are tangible. Great focus on invetigation and doing – no spoon feeding!*
  (Education professional – teacher)

Structure of the curriculum

Question 15: To what extent do you agree with this approach to organising science content for Stage 3?

Strongly Disagree	Disagree	Agree	Strongly Agree
4%	20%	47%	29%

Question 16: Please comment.

Many respondents called for consistent language use across the stages of schooling, particularly in Stage 3 and Stage 4 (while maintaining an integrated approach to the study of science in Stage 3). Continuity of language was seen as important to aiding students to identify their interests and strengths. Respondents sought the inclusion of more specific advice about opportunities for differentiating the curriculum in the latter half of Stage 3.

- *The Stage 3 topics and major concepts course indicates an unfortunate departure from the Stage 2 course; the continuum of learning emphasised in the Stage 2 curriculum needs to flow on into secondary school if the national curriculum is to be a seamless and successful learning path for students.*

  The Stage 3 topics and major concepts should be re-imagined into a series of multi-disciplinary topics that will increase the scientific literacy of the Australian population.

  It is important that the key concepts are presented in a multidisciplinary manner, rather than as separate disciplines of science eg atomic structure is important in chemistry in terms of reactions, equally it is important in physics in terms of conductors and insulators. It is also important in astronomy in terms of identifying the composition of astronomical objects. Atomic structure should not be identified just as a chemistry concept.

  The "content" for the Science as a human endeavour element must be made explicit, just as the skills and knowledge and understanding will be prescribed. If this is not done, but left as a vague, overarching statement then it will drop off the priority list for teachers. They will focus on the knowledge and understanding and skills which have been explicitly prescribed. (Professional association)

- *Para 52: 'Providing a unit in which students conduct a science investigation in an area of their choosing' is viewed as potentially affirming for students but potentially challenging for some teachers, particularly in relation to their own expertise and resources available. Recommended that guidance for teachers be provided.*

  Para 54: Recommend that further explicit parameters be provided in the national science curriculum for determining what 'topics and major concepts' students should study. This will ensure the building of a sound knowledge base, avoidance of an overcrowded curriculum and consistency across the states.

  Para 55: Strong support for differentiated programs in Stage 3. Students must be well prepared for specialisation in Stage 4.

  Suggestion to embed 'Contemporary science' content across the sciences in Stage 3 Table.

  Suggestion to include 'solar system' as a dot point under 'Earth and space sciences' in Stage 3 Table. (Education authority)

Structure of the curriculum

Question 17: How many science courses should be included in the national science curriculum in the senior secondary years of schooling?

Question 18: Please comment.

Respondents largely supported the proposed provision of physics, chemistry and biology as senior secondary courses with an earth and environmental science course seen as a preferred option to an environmental science course. There was some discussion about a further interdisciplinary course while respondents indicated support for existing courses across the states (for example, Human Biology, Agricultural Science and Psychology) to be retained as specialised courses.

- *It is recommended that the development of five courses in the senior years of schooling would meet the multiple external demands on a national curriculum – Science for citizenship and science as preparation for post-compulsory studies, however, further clarification is required in relation to the nature of these courses.*

  Environmental science should be a combined/integrated Environmental and Earth Science Course otherwise we fail to recognise a major area of scientific endeavour and work in this country.

  'Science for life and work' as a multidisciplinary course for students not wanting to pursue post-compulsory science studies is applauded, however, its title is likely to be unpalatable with many. While this is admittedly a perception issue we must recognise the power of perception in driving choice and take-up of courses. (Education authority)

- *Physics, Chemistry and Biology are generally accepted courses in all states and territories at the Senior Secondary level. We would strongly suggest that the "Environmental Science" course be expanded to "Earth and Environmental Science". This course has seen a significant increase in the uptake of students since it was introduced in NSW in 2001, when compared to the previous "Geology" course. The combination of Earth Science and Environmental Science represents a natural synergy of scientific ideas and concepts as environmental issues cannot be discussed in isolation; environmental issues impact on the Earth and equally the Earth's processes impact on the environment.*
  (Professional association)

- *The fourth course should be Earth and Environmental Science. it is impossible to study environmental science without a knowledge of earth science and geology. Earth and Environmental Science (EES) is an integrated science that encompasses all other sciences but can be studied at a number of different academic levels using many different local, regional and national contexts.*
  (Business and industry stakeholder)

- *Environmental Science would better be replaced by Earth and Environmental Science (EES). With the latter title, senior secondary courses such as the new EES in WA and the resurgent Geology in SA would fit well under this broader banner. Otherwise, 'Geology' (particularly) could hardly be regarded as 'Environmental Science' and there would be no studies of 'the Earth' under the senior secondary National Science Curriculum. It is important the students be given some opportunity to study 'the Earth' at senior level, because of it's relevance to all science (not just 'environmental science'.*
  (Educational professional – teacher)

Pedagogy and assessment

Question 19: This section outlines approaches to pedagogy as they apply to the content of a national science curriculum. To what extent do you agree?

Strongly Disagree	Disagree	Agree	Strongly Agree
4%	8%	45%	43%

Question 20: Please comment.

There was general support for the statements about pedagogy in the framing paper. In relation to the statement that there needs to be more emphasis on student engagement and inquiry and less on teacher transmission, it was considered that a variety of effective pedagogies need to be employed to ensure that science education reflects accurate scientific thought and practice with schools able to select approaches that suit their ethos, values or philosophy.

- *We support the pedagogical approach outlined in the Framing Paper. It will be imperative, however, for this to be successful that there is sufficient time to cover the curriculum using student engagement and inquiry. The transmission model is frequently used when time is at a premium, however, this does not allow deep understanding to occur. It will also be imperative that appropriate and targeted professional learning opportunities are provided to all teachers of science to ensure that all teachers engage with the national curriculum documents and the pedagogy underpinning it.*
  (Professional association)

- *The value of an inquiry approach to learning in science is strongly acknowledged, however, the purpose of curriculum is not to dictate pedagogy but rather enable it. This enabling capacity will need to be embedded in the curriculum as it is developed.*

  If the experiences of students are to approximate what occurs in the real world, then there needs to be opportunity for teachers to provide access to a range of learning experiences and use a variety of teaching strategies. Question 19 refers to 'models' of pedagogy however the Framing paper focuses solely on Inquiry. (Education authority)

- *As noted in paragraph 59 of the Framing Paper, to achieve the stated aims of the National Science Curriculum there needs to be less emphasis on teacher's explaining to students how science works, and more of a focus on student engagement and inquiry. A model based on teacher's asking more questions and discussions will result in greater student engagement.*

  We view that pedagogy is inextricably linked to resources… It appears clear that without adequate teaching resources, the art of teaching is compromised. These considerations need to be in the forefront of curriculum writer's minds, as a truly modern and engaging curriculum will only be as good as the support that accompanies it.

  We recognise that effective teachers use an array of teaching strategies because there is no single, universal approach that suits all situations. Different strategies used in different combinations with different groupings of students will improve learning outcomes. Some strategies are better suited to teaching certain skills and fields of knowledge than are others. Some strategies are better suited to certain student backgrounds, learning styles and abilities. Again, our view is that considerations for teaching styles and situations need to be considered in constructing the national curriculum.

  It is important that the National Science Curriculum encourages teachers to use an array of different teaching strategies that support student engagement and connectedness to the wider community and industry. (Business and industry stakeholder)

- *Not enough emphasis on developing working scientifically skills and a pedagogy that enables multiple entry and exit points within an area of study.* (Educational professional – teacher)

Pedagogy and assessment

Question 21: This section outlines approaches to assessment as they apply to the content of a national science curriculum. To what extent do you agree?

Strongly Disagree	Disagree	Agree	Strongly Agree
2%	11%	53%	34%

Question 22: Please comment.

There was general support for the statements about assessment in the framing paper. The reference to the 'backwards design process (Wiggins and McTighe: 2005) was supported, and also respondents suggested that greater emphasis could be included about the various purposes of assessment such as assessment for learning (diagnostic assessment), assessment as learning (formative assessment) and assessment of learning (summative assessment). It was considered that the framing paper needed to state the importance of assessing all three elements specified in the structure of the curriculum.

- *Assessment is integral to learning. It is essential that information regarding possible assessment tools is part of the curriculum documentation. It is also important that assessment of all elements occur, including Science as a human endeavour. Frequently, assessment focuses on science understanding and science inquiry skills. This does not assess understanding of the concepts and skills of science in specific applications, historical contexts or contemporary issues. To ensure that scientific literacy is the focus, assessment must cover all elements in the curriculum.* (Professional association)

- *Assessment is a crucial component in the planning and implementation of educational programs. Further advice is needed about:*
  - *modes of assessment, including assessment to improve student learning*
  - *how assessment relates to pedagogy and the development of science capabilities*
  - *assessment requirements*
  - *achievement standards in describing overall student achievement.*

  (Education authority)

- *The backwards design is good in theory, but for Stage 4 the stakes are clearly very high and much more detail about assessment will need to be made public at the same time as the curriculum intent. In Western Australia the new Year 11 and Year 12 courses had to be considerably altered because assessment was not considered carefully enough during the course writing process. As a consequence, enormous resources were wasted.* (Academic)

- *The framework for the curriculum and the focus of assessment should be based on what it valued, so that assessment can safely drive the focus of the curriculum. Teachers would be clear about objectives, how well these objectives were being met and how performance was improving.*
  (Educational professional – teacher)

Question 23: Do you have any other comments to make on the paper?

Respondents produced a variety of comments in regard to the paper. The responses included ideas for inclusion in the paper, reactions to the pedagogy and assessment section of the paper, affirmations of the intent of the paper, comments that are outside the scope of the national science curriculum at this stage and ideas for the development phase of the national science curriculum.

- *The paper needs to articulate a clear continuum of learning across the K-12 science curriculum. The descriptions of content at each stage of the syllabus seem to stop at stage 3 with stage 4 yet to be developed.*

  The nature and structure of the stages also needs to be clarified. It is understood that the stages of schooling will be determined shortly.

  It is essential that the national science curriculum enables and supports student engagement with a deep understanding and development of enabling science knowledge understanding and skills for citizenship in the 21st century. The curriculum must focus on depth of knowledge, understanding and skills. (Education authority)

- *Good to see the focus on depth rather than breadth.*

  Good to see recognition that modern science is mostly integrated and cross disciplinary and that this must be taken into consideration in the school curriculum. At the same time the basic ideas from the major science disciplines for the basis of much of the science that students should learn in school.

  I noticed some inconsistency in the terminology used for topics or the science disciplines. E.g. "geosciences" (p. 5), cf "earth and space sciences" (p. 6); and "physics, chemistry" (p. 5), cf "physical sciences" (p. 10). Consistency would be very helpful. (Academic)

- *It must be clearly articulated in the curriculum documents the depth of understanding required by students at the end of each stage. Are the students required to "identify", "describe", "explain" "discuss" etc? This will determine the depth and also the time that may be required to address the concept or element.*

  There are many historical examples that indicate that the intent of curriculum documents do not become embedded in practice unless there is significant and appropriate professional learning opportunities for all teachers of science. The teachers must have a deep understanding of the documents before they can effectively use them to inform their practice. Hence, there must be provision for significant and appropriate professional learning opportunities for teachers of science before the beginning of the implementation phase of the National Science Curriculum.

  There is also a need to ensure that there is sufficient resourcing of all schools to ensure that the National Science Curriculum can be implemented effectively. This is particularly appropriate in late Stage 2 science where students in some states and territories will have the resourcing available in Secondary Schools while others will have the resourcing available at Primary Schools. The resourcing must be sufficient for all schools. The resources available will influence the types of learning opportunities available to students. (Professional association)

- *Thank you for this opportunity to comment. Despite my many 'disagrees' I am largely supportive of the essence and direction of this framework, and delighted that we are at last working together as a nation to have a national curriculum. Hopefully it will be easily used for pedagogy and assessment and allow for the development of energised passionate science teaching!* (Educational professional – teacher)