The Association for Science Education

Promoting Excellence in Science Teaching and Learning

Primary Curriculum Review

A response from

THE ASSOCIATION FOR SCIENCE EDUCATION

July 2009

Contents of this response:

INTRODUCTION

The Association for Science Education (ASE)[1] welcomes the opportunity to make a response to the Primary Curriculum Review and has consulted widely with its members in order to bring together a range of evidence from a variety of perspectives. ASE members are drawn from all phases and areas of science education. In particular ASE's Council, Primary Science Committee and Special Interest group of National Advisers and Inspectors Group for Science (NAIGS)[2] have contributed to this response. We have also drawn on ASE's previous recent consultation responses; in particular our response letter to the Interim Report (January 2009) and to The Primary Review: the condition and future of primary education in England (April 2007).

[1] a summary of the aims of the Association for Science Education appears at the end of the document

[2] a summary of the aims of the National Advisers and Inspectors Group for Science appears at the end of the document

ASE's submission focuses on some of the questions raised on the principles and content of the primary curriculum and its fitness for purpose, and on the proposed management of the primary curriculum. The key messages are summarised below:

KEY MESSAGES

Principles

1. The National Curriculum should provide a basic framework of objectives for the development of subject knowledge, skills and conceptual understanding, around which teachers have the freedom to make decisions on how to achieve these objectives and to explore the subject with their students.
2. ASE welcomes several aspects of the final report including the intention of the primary curriculum to reduce prescription and increase teachers' flexibility to meet the needs of different schools and their pupils.
3. ASE welcomes the recognition of the importance of subjects and that subject knowledge and understanding can be strengthened through a range of teaching and learning opportunities, including cross curricular approaches.
4. ASE recognises the importance of numeracy and literacy, together with ICT as priority areas to be taught and experienced through the six areas of learning, and underpinned by learning, thinking and enquiry skills of Essentials for Learning and Life.
5. ASE recognises the rationale for creating six areas of learning and for coupling science together with design and technology to the benefit of both subjects. However the diagrammatic model on page 47 of the Final Report and supporting text give little indication of the relationship between the areas of learning and of the need to spend adequate time on each of the subjects, either together with other subjects or discreetly.
6. ASE regrets the lack of consistent threads across the various elements of the proposed primary curriculum with the earlier and later stages of a child's education; no doubt resulting from piecemeal changes and the prior publication of the Early Learning Goals and the KS3 science curriculum. ASE regards this lack of continuity and coherence as a serious flaw.

The position of science

7. Science, with its focus on enquiry, objectivity and rationale, provides a unique contribution to the cognitive development of young people, from their early years onwards; and therefore fully justifies a greater emphasis within the whole curriculum.
8. With the current government focus on the need for top quality scientists to maintain the UK's position as a world economic leaders for science and technological innovation, a science National Curriculum that is an entitlement to all and appeals to our future scientists, as well as creating an increasingly scientifically literate youth population, is now even more necessary than in previous years.
9. For science specifically, the confusing use of the term 'core' has left many schools uncertain as to the status of science in the proposed curriculum as evidenced by reports to ASE staff and members. Head teachers and curriculum

planners will need clarification to remind them that schools continue to be accountable to government for the attainment of their pupils at KS2 in national standards for science; and hence that adequate curriculum time, resources and teacher experience are required to fulfil that commitment.

Science and technological understanding

10. ASE welcomes an area of learning that focuses on science, with technology and design. However the overall framework, the treatment of progression and some of the details in the programme of learning are at odds with expectations set out on page 11 of the Final Report.

11. The proposed structure and organisation of this area of learning creates difficulties for teachers and curriculum planners in interpretation, and in planning to provide the desired experience for pupils within science, and in science together with design and technology, and across the other areas of learning.

12. Our concerns about the content of this area of learning follow from recognition of the advances in the past two decades in understanding of primary school science education and its role within primary education as a whole. There is clear evidence that children's ideas and understanding of science, and engagement with it, develop through practical investigation and other forms of enquiry. A combination of scientific enquiry and thinking skills is essential in the development of science ideas and understanding, and reflection of how these ideas are developed can be a basis for understanding the nature of science. A coherent progression in skill development is essential and should be made explicit across the three stages.

13. Greater clarity is required and use of identical connecting language between the different sections of the area of learning to allow easier interpretation and planning for effective progression. For instance, the statements within Essential Knowledge need to be clearly identifiable within Curriculum Progression.

14. In several places in the Final Report, the curriculum is described as 'an entitlement of all children'. This is to be applauded, but to better reflect pupils' entitlement, it may be more appropriate to rephrase the rubric introducing the statements in the curriculum progression from 'Children should be taught' to 'Teachers should provide opportunities for children to… ' and for progression in knowledge and understanding 'Teachers should provide opportunities for children to use appropriate skills to develop knowledge and understanding of '. We strongly advise this change in wording as being more consistent with the spirit of describing the prescribed content as representing a national entitlement, as in paragraph 2.29.

Curriculum progression

15. The three stages (early, middle and later) within Curriculum Progression are welcomed as having the potential to identify progression in children's learning. However the current structure does not help teachers plan easily for progression in enquiry skills nor conceptual understanding, in science in particular. The statements require some rearrangement in order to serve their intended purpose and to show how each relates to progression in the major areas of science knowledge and understanding. Additionally, schools may need to be reminded that the stages are not to be interpreted specifically as age related.

16. The progression statements should better reflect the purposes of primary science education; valuing children's ideas about science and encouraging them to have ownership of their learning.

17. ASE welcomes the aim of reducing the detail in which the curriculum is set out. However the device of 'explanatory notes' which elaborate the main statements is an unsatisfactory way of retaining a great deal of the detail that is in the existing National Curriculum. Teachers have made it quite evident to us that these two tiers of prescription make the document unwieldy to use and restricts their freedom.

18. There are difficulties in cross referencing the proposed curriculum progression documentation which teachers will use in their planning, with the revised level descriptions; not least because the progression documentation attempts to bring together skills, conceptual knowledge and understanding across science, and design and technology; but the level descriptions for both subjects remain distinct and separate.

Implementation

19. It is appropriate for all children, regardless of circumstances, to have an entitlement to certain opportunities to learn through a broad and balanced curriculum within the years of statutory education and this should not be left to the interpretation, resources and expertise of individual teachers and schools.

20. Teachers have an important role in developing and taking ownership of the curriculum that they teach so they are instrumental in making it (science) engaging for their own pupils in their own circumstances.

21. Any positive changes to the National Curriculum (and its testing and assessment regime) need to fully engage teachers through allowing adequate time to fully consult on, pilot and evaluate the effects of proposed changes. Teachers are vital to the successful implementation of any curriculum change and they will need time to prepare for such changes. Relevant and timely professional development is required so that teachers are able to implement the changes with confidence based on sound subject knowledge and professionalism. ASE would welcome the opportunity to be involved in developing and implementing a range of professional development measures alongside government and other key organisations.

A RATIONALE FOR A CHANGED APPROACH

The Association for Science Education welcomes several aspects of the proposed programmes of learning, such as the intention to provide an explicit statement of the importance of scientific and technological understanding; to identify progression; and provide a reduction of prescribed content. However, we find that the overall framework, the treatment of progression and some of the details in the programme of learning are at odds with expectations set out in paragraph 11 of the Final Report. As the nation's major organisation concerned with school science education, we have given a great deal of thought and time to the suggestions offered here, in order to set out how and why we would wish the curriculum document to be changed rather than only to offer general comments.

Scientific and technological understanding: general points

In the past two decades there have been considerable advances in the understanding of primary school science education and its role the whole of pupils' science education, which do not appear to have been recognised in this document. This role has become increasingly important in the face of evidence of the importance of what is summed up as 'a scientifically and technologically literate population' and of engaging more students in advanced study of science and technology. These things may seem a long way from the primary school, but the research has shown that the roots of understanding and of motivation to engage are established at the primary level.

Across the world research has shown that children form ideas about the scientific aspects of the world from their earliest years and that these ideas are often in conflict with the scientific view. The work of Rosalind Driver and her team in the CLIS project, for instance, showed that when these ideas are taken into the secondary school they impede the development of concepts and deter interest and motivation for further study. At the same time the work of the SPACE project showed that it is possible to begin to develop more scientific ideas in the primary school children through practical investigation and other forms of enquiry. There is clear evidence that a combination of scientific enquiry and thinking skills is essential in the development of these ideas and that reflection on how ideas are changed can be a basis for understanding the nature of science. Essential to this development is a clear notion of progression in both the skills used in enquiry and in design and technology and the ideas of science that are developed through enquiry and used in technology.

Specific points in relation to scientific and technological understanding

Curriculum progression: skills

A coherent progression in skill development is essential at the primary level. We consider that this should be made explicit for development in science enquiry and technology skills across the three stages. We have illustrated such a progression for skills relating to 'how science works' separately. We consider that setting out the skills fully in this way (which we have not had time to do within this consultation period but would willingly undertake) would make it unnecessary to pick out just the few that are specified in relation to certain content as in the statements of curriculum progression. The specification of certain skills where many others may effectively be used may restrict their use and development.

Although in studying a particular topic, skills of science and technology may both be used they are nevertheless distinctly different skills. Science enquiry skills are used in developing understanding by finding out which ideas are supported by evidence and help in our understanding of a range of related phenomena. Technology skills are used in designing, producing and evaluating artefacts and systems to solve problems and meet human needs. We consider it important for teachers to be aware of progression in both types of skill and to have these in mind especially in topics where they are combined – just as teachers have the development of literacy skills in mind in topics where science skills are also developed and used.

It would be logical to be able to map these skills to the Essential Skills in the curriculum framework and to the Level Descriptions. However this is impeded by the lack of consistent threads across the various elements of the proposed revised

primary curriculum, no doubt resulting from piecemeal changes and the prior publication of the Early Learning Goals and the KS3 science curriculum. We regard this lack of continuity across different phases and lack of coherence within the parts of the primary curriculum as a serious flaw.

Curriculum progression: knowledge and understanding

We appreciate that the aim of setting out the programme of learning in terms of Early, Middle and Later stages is to help teachers identify the point in progression that their pupils have reached. This enables them to identify the next steps and so ensure that ideas and skills are progressively developed. We consider, however, that the statements need some rearrangement in order to serve the intended purpose and to show how each relates to the major generalizations in science. We have identified these major generalisations as relating to:

- The nature of science, technology and design
- Living organisms and the environment
- Materials and how they can be changed
- Motion and forces
- Energy
- The Earth and the solar system

The addition of 'The nature of science, technology and design' fills a gap in relation to the development of knowledge and understanding of the nature of science and of technology (including design) and their interaction. The recognition of what is different between science and technology is essential to understanding how they interact, how science is advanced through technology and how technology uses the knowledge – particularly of materials, forces and energy – from scientific enquiry. We consider this understanding can begin in the primary school.

Under each heading we would like to see the statements arranged so that clear progression in what is learned is set out. In order to do this, and to identify *the ideas* to be learned it has been necessary to rephrase and remove the initial statements relating to how the content area is to be treated. That is, we removed words such as 'to identify, group and select...' since these do not help in making clear the ideas to be developed, but rather suggest activities.

In so doing we are aware that the conceptual learning has been separated from the skills and that there may be a danger of this leading to the separation in children's experience, which is not intended. Indeed it is for this reason that we have suggested (below) a different presentation of the overall framework. But we consider that a statement of the curriculum should set out what pupils are to learn and not how to teach and that other parts of the document and supporting materials will make clear that the knowledge and understanding is developed through investigation and other forms of enquiry. We also note that this presentation of knowledge and understanding is consistent with the KS3 curriculum for science.

Reduction in prescribed detail

Again, ASE welcomes the aim of reducing the detail in which the curriculum is set out. However, the device of having 'explanatory notes', which elaborate the main statements is an unsatisfactory way of retaining a great deal of the detail that is in the existing national curriculum. Teachers have made it quite evident to us that these two tiers of prescription make the document unwieldy to use and restricts their

freedom. We have found it quite possible to incorporate essential items from the 'explanatory notes' into the main statements, making the progression clearer and more readily usable as a planning tool.

An 'entitlement' curriculum

In several places in the Final Report the curriculum is described as 'an entitlement of all children'. This is to be applauded and ought to be reflected in the rubric introducing the statements in the curriculum progression. This is why we have proposed that the leading statement for progression in skills should be 'Teachers should provide opportunities for children to... ' and for progression in knowledge and understanding 'Teachers should provide opportunities for children to use appropriate skills to develop knowledge and understanding of....' We strongly advise this change in wording as being more consistent with the spirit of describing the prescribed content as representing a national entitlement, as in paragraph 2.29 of the report.

MODIFICATION OF THE FRAMEWORK

Our suggestions for modification of the framework, as presented on page 47 of the report, have arisen from our knowledge and concern about science and technology education but apply more widely in primary education. We agree that numeracy and literacy are priority areas of primary education and propose that they should be represented in the overall aims, reworded as:

- Numerate and literate individuals
- Confident and enquiring learners
- Responsible and engaged citizens

rather than a 'core' of skills (literacy, numeracy and ICT). The next layer of the framework would reflect the wider range of aims to be achieved through all the areas of learning reflecting the full range of 'essentials for learning and life' on pages 75 and 76 of the report.

REWRITTEN "WHY IS THIS AREA OF LEARNING IMPORTANT" AND "ESSENTIAL KNOWLEDGE"

We suggest the following improved wording for these statements below:

Why is this area of learning important?

Children live in an age of fast moving science and design and technology. This area of learning is fundamental to exploring, understanding and influencing the natural and made worlds in which we live. It provides access to a wealth of experiences and ideas that encourage children's natural curiosity and creativity. This helps to kindle inventiveness, and inspire awe and wonder. Science supports the development of technology and advances in technology lead to new scientific discoveries, shaping how we live safe and healthy lives in our rapidly changing society.

This area of learning helps children to embrace new ways of looking at the world and to engage with changing explanations about how the world works and progresses. They learn to value ideas and to see talking, thinking and imagining as essential elements in how understanding grows and how new processes are generated.

Children who develop confidence in science and design and technology know how to seek answers to problems. They develop a repertoire of valuable skills that enable them to form questions, generate and test ideas and decide how to seek solutions. They can gather and make sense of evidence through, for example, practical investigations, testing or research using secondary sources and evaluate processes and outcomes. By learning the importance of distinguishing evidence from opinion they are better able to make informed choices throughout their lives and to be active and informed citizens responsive to the needs of others and the world in which they live. Through the skills, knowledge and understanding that they develop, children are better armed to be lifelong learners and to see science and design and technology as a natural and essential part of their lives, whatever their futures in the world might be.

Essential knowledge

The following is a restatement of the "Essential knowledge"

Science, technology and design are creative processes that use ideas and evidence to explore and explain our world, solve problems and bring about change.

The living world has a great and changing variety of plants and animals (including humans). These are interdependent. Humans can engage with, and influence, their environment.

The world is made of a variety of natural and made materials. Materials have properties that can change and these determine how they are used.

Objects don't move or change unless a force causes this to happen. Sometimes these forces can be controlled.

Energy can be experienced through the effects of natural phenomena such as light, sound and electricity. Humans can engage with, and sometimes control, these in our everyday lives.

Our planet, the Earth is part of the Solar System. The seasons, day and night, and weather patterns happen because of the relationship between the Earth and Sun. Technology helps us to understand more about the Earth, its processes over time and its place in the Solar System.

CURRICULUM PROGRESSION

Statements under the heading 'Across the area of learning'

We consider that the statements currently under the heading 'Across the area of learning' should be restructured to give a greater sense of progression across the three phases and its connection to 'How science works' at KS3. In the case of the primary curriculum this should become 'How science, technology and design work'. We would want to work with colleagues from the Design and Technology Association over a longer period of time to identify the headings suitable for including D&T. But to exemplify the structure and to give some idea of what we would like to see included for science we set out here some statements for two components: 'Raising questions and developing ideas' and 'Collecting and recording scientific evidence.'

The statements have been reworded to match a revised lead statement, but are derived from the original statements, in the progression statements and the explanatory notes, indicated in brackets.

Early	***Middle***	***Later***
Teachers should provide opportunities for children to: **Raise questions and develop ideas**		
o explore, observe, show interest, notice changes, ask questions, talk about their ideas (E1, 13)	o explore, investigate, raise questions and suggest reasons or predictions based on their ideas (M1, 23)	o raise questions that can be answered by practical investigation or other forms of enquiry and decide the best approach to use (L1)
Collect and record scientific evidence		
o collect simple data and information to answer questions (E1, 15)	o decide what information to collect and how to record it (E1, M3, 23) o use a range of equipment including sensors to gather data (36)	o decide how to make and record accurate measurements and detailed observations (L3) o choose equipment, including ICT, to make their work more effective and explain the reasons for their choices (L2)

Scientific knowledge and understanding

We are strongly committed to indicating the lines of progression in scientific knowledge and understanding more explicitly. We believe that within these lines of progression it would help to show the relationship between science and design and technology in a way that can support teachers. We also feel that the Nature of science (technology and design) is an omission. This should be clearly separated from skills and process or 'How science works' (as currently identified in the section 'Across the Area of Learning'). In all these aspects we would want to work with colleagues from the Design and Technology Association over a longer period of time to identify what the statements could be.

Exemplification of what this might look like in relation to the science statements is given below. We have inserted new statement where we considered additions to be

needed. (For example, in the addition of statements across all stages in relation to 'The nature of science' and adding to those relating to 'The Earth and the solar system'). Other statements, referenced to the consultation document, have been reworded in an attempt to clarify and simplify them. All statements have been worded to match a revised lead statement: '*Teachers should provide opportunities for children to use appropriate skills to develop knowledge and understanding of*'. As noted in our response, we are firmly of the opinion that this better conveys the spirit of an entitlement curriculum.

Early	***Middle***	***Later***
Teachers should provide opportunities for children to use appropriate skills to develop knowledge and understanding of: **The nature of science**		
o how some questions can be answered through a process of exploration and enquiry	o how ideas used in explaining things depend on the evidence available at a certain time	o the role of evidence in changing ideas, both historically and in their personal understanding
Living organisms and the environment		
o what plants need to grow (E12) o how to look after themselves and other animals (E12) o differences and similarities between familiar living things (M12) o their local environment and how they can care for it (E13)	o how to look after plants (M14, 33) o how to keep themselves and other animals healthy (M14) o the diversity of animals and plants, and how they depend on one another in a particular environment (34) o the features of the local environment and what lives in it, and how to improve it (M15)	o how plants are grown, and used, around the world (L15) o how key human body systems work and what can influence them (L14) o the beneficial and harmful effects of micro-organisms (L16) o how animals and plants have evolved to suit their environment o the features of more than one environment, the interdependence of what lives in them, and how to take action to care for and protect these environments (L17)

Materials		
o familiar natural and manufactured materials and how they can be used (E4, E5, E6, 16, 17)	o suitability of materials for different purposes and how to change and use materials (M12, M13, 30) o how materials are grouped according to their properties, including solids, liquids and gases (M12, 28)	o reversible and non-reversible changes, including how to create new materials o the impact of the manufacture, use and disposal of materials on the environment (L19, 47)
Motion and forces		
o how to make things move o simple mechanisms and structures	o the effects of different forces and how these can be used	o use and control combinations of forces
Energy		
o simple electric circuits and how electricity is used safely (E10) o sources of light and sound and how we sense them (E 11) o keeping things warm and cold (18)	o electrical conductors and insulators and how they are used to control the flow of an electric current in a circuit o how shadows and sounds are made (M10) o thermal conductors and insulators and how they can be used	o the effects of changes in electrical circuits and how these can be used (L9) o how the properties of light and sound explain how we see and how different sounds are made L10, 40) o how energy can be conserved
The Earth and the solar system		
o day and night and the changing seasons	o how day and night are explained o weather patterns and seasonal changes o what the Earth is made of (M15, 34)	o daily and seasonal changes, and time measurement (45) o the Earth's place in the Solar System (45) o how the surface of the Earth changes over time

Whilst this is a submission from ASE with a focus on science, we have shared these developments at different stages with key organisations with whom we often work in partnership, including SCORE (Science Community Representing Education), the national network of science learning centres and the Design and Technology Association. We would welcome the opportunity to work with government and these organisations to ensure that the primary curriculum reflects the needs of the subjects of science, and design and technology.

Annette Smith

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Association for Science Education

On behalf of the many science teachers, researchers and advisers who have contributed to this response

The Association for Science Education is the largest school-subject association in the UK. ASE provides a UK-wide network for teachers, researchers, technicians and others interested in science education. ASE is a registered charity incorporated by Royal Charter.

The National Advisers and Inspectors Group for Science (NAIGS) supports Science Advisers, Inspectors, Science Consultants and others working in an advisory or support capacity for continuing professional development in science education. NAIGS is a Special Interest Group of ASE.