SCIENCE

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

SCIENCE
in the National Curriculum in Wales

Key Stages 2–4

Department for Education, Lifelong Learning and Skills

Consultation document
January 2007

Title of document

Science in the National Curriculum in Wales

Audience

Headteachers and governing bodies of maintained schools in Wales; local education authorities; teacher unions and school representative bodies; church diocesan authorities; national bodies in Wales with an interest in education.

Overview

This document sets out the Welsh Assembly Government's proposed changes to science in the national curriculum in Wales.

Action required

Responses to this consultation document must be received by 30 March 2007. Responses can be sent to the address shown below, using the freepost envelope provided, or submitted electronically to curriculum@beaufortresearch.co.uk Alternatively, online questionnaires are available at www.wales.gov.uk/consultations

Further information

Enquiries about this consultation should be directed to Mark Lewis on 029 2037 5485.

Additional copies

Can be obtained from:

Tel: 029 2037 5427

Fax: 029 2037 5494

Or by visiting the Welsh Assembly Government's website www.wales.gov.uk/consultations

Address for return of comments

Curriculum Consultation
Beaufort Research
FREEPOST
Cardiff
CF10 1YS

ISBN: 0 7504 8994 4

Ref: AC/CD/0734

First published 2007

Contents

Introduction

This document contains the proposals for science in the national curriculum in Wales. These are for consultation. The consultation lasts until 30 March 2007. It would be helpful if you would submit your views on the response questionnaire provided with the consultation pack or respond via the website at www.wales.gov.uk/consultations

Wales Curriculum 2008: The objectives

The Welsh Assembly Government intends that, from 2008, there exists in Wales:

- a single coherent framework for curriculum, assessment and qualifications 3–19 which will help schools to raise standards of achievement and widen educational opportunity
- a set of revised subject Orders which are manageable and reflect whole curriculum characteristics and those of each key stage.

The agenda for the development of this revised curriculum and assessment framework for Wales is based on the Minister's acceptance of the key recommendations in ACCAC's *Review of the school curriculum and assessment arrangements 5–16: A Report to the Welsh Assembly Government April 2004*. That report described the context for the review and the evidence that was gathered to inform ACCAC's advice.

Advisory groups for cross-phase (primary and secondary) and additional educational needs worked alongside the personal and social education and subject advisory groups to help revise the curriculum.

In revising the subject Orders, opportunities have been taken to:

- revise the Common Requirements section to clarify each subject's contribution to developing skills across the curriculum, the Curriculum Cymreig, and personal and social education
- review the use of the icons for skills and other requirements to give a fuller picture of opportunities for skills development and application
- revise the 'Access for all pupils' text to clarify breadth and depth of study, and to ensure inclusion and accessibility for all pupils, especially those with additional educational needs
- revise and rename focus statements to reflect the focus on skills development and application, and to provide an overview of what is involved in each key stage for each subject

- develop a common structure – Skills and Range – initially identifying the required skills for each subject and then the range of contexts, opportunities and activities through which these skills should be developed
- use the non-statutory skills framework to underpin the review of the subject Orders, adding text consistent with that used in the skills framework to indicate where opportunities and contexts exist to develop skills across the curriculum
- update and reduce content where necessary to ensure relevance to the twenty-first century, taking account of learners' personal development and well-being, their preparedness for citizenship, community life and employability within a bilingual Wales, and education for sustainable development and global citizenship
- add non-statutory examples where necessary to clarify key experiences and learning opportunities
- redraft level descriptions, where necessary, to indicate clearly progression in skills relevant to each subject, and to recognise the progress of pupils who are working below Level 1
- remove references to the Key Stage 2 and 3 Programmes of Study from the level descriptions
- reduce the level of prescription in the Key Stage 4 Programmes of Study to allow qualifications that provide different and more inclusive pathways through each subject, giving learners greater opportunities for choice and participation.

Commentary on the proposals: key changes

The main changes to the current (2000) Order are:

- The programmes of study across Key Stages 2 and 3 follow the same structure with generic skills being relevant and integral to the whole range to create maximum choice and flexibility in a broad and balanced curriculum.

- Each of the sections: Independence and interdependence of organisms, The sustainable Earth and How things work (KS2)/Energy (KS3), has an overarching statement or aim to enable teachers to see the 'big picture'.

- Scientific Enquiry has been subsumed into the Skills section, which also reflects the skills of Developing thinking, Communication, Number and ICT. In addition, types of enquiry have been identified which differ from the traditional fair test enquiry to guide teachers to a wider range of enquiries.

- The enquiry part of the Skills section has been split into the three main Developing thinking areas: Plan, Develop and Reflect, to make these processes explicit to teachers.

- In general, the statements from the national curriculum science Order 2000 have been combined and generalised to increase flexibility and better allow teachers to take account of pupils' prior learning and so target teaching at gaps or misconceptions in pupils' skills, knowledge and understanding. Some statements have been removed to allow for better progression from the Foundation Phase and into the core Key Stage 4 Programme of Study.

- At Key Stages 2 and 3, Life Processes and Living Things has been replaced with Independence and interdependence of organisms. At Key Stage 2, it is expected that pupils will have the opportunity of fieldwork in order to compare two local environments. At Key Stage 3, statements concerning human activity and its effect on environments and how medicine and technologies can affect the quality of life have been added.

- At Key Stages 2 and 3, Materials and their Properties has been replaced with The sustainable Earth. At Key Stage 2, pupils will study recycling and therefore, although reference to separating materials is not explicit, it is expected that they will study how materials to be recycled are separated. At Key Stage 3, a statement referring to the uses of sustainable materials has been added.

- At Key Stage 2, Physical Processes has been replaced with How things work with the emphasis being on using science to explain how everyday machines, instruments, toys and devices work. At Key Stage 3 Physical Processes has been replaced with Energy. The Forces and Motion section has been removed and statements on work done and new energy technologies have been added.

- The existing four attainment targets have been combined to make a single attainment target. This emphasises the importance of skills in science and the opportunities to make links across the range of learning.

- Level descriptions have been revised to reflect changes in the programmes of study. The pitch and challenge remain the same. Aspects of progression between the descriptions have been clarified.

- At Key Stage 4, the programme of study has the same overall structure of Skills and Range as the previous key stages but follows the requirements already agreed between Wales, Northern Ireland and England from which the new GCSEs in Science derive. These began in September 2006.

Responsibilities on schools

Under the requirements of equal opportunities legislation covering race, gender and disability, schools in Wales have a duty towards present and prospective learners to:

- eliminate discrimination and harassment and promote positive attitudes
- promote equal opportunities and encourage participation in all areas of school life.

Every learner should develop a sense of personal and cultural identity that is receptive and respectful towards others. Schools should plan in all subjects to develop the knowledge and understanding, skills, values and attitudes that will enable learners to participate in our multi-ethnic society in Wales. Schools should develop approaches that support the ethnic/cultural identities of all pupils and reflect a range of perspectives, to engage learners and prepare them for life as global citizens.

Schools must work to reduce environmental and social barriers and provide an inclusive curriculum which will offer opportunities for **all** learners to achieve in school in preparation for further learning and life.

Schools will need to plan and work with specialist services to ensure relevant and accessible learning experiences for all. For learners with disabilities in particular, they should make reasonable adjustments in order to:

- improve access to the curriculum
- increase access to education and associated services
- provide information in a range of formats.

Schools should provide access to appropriate equipment and approaches with alternative/adapted activities to ensure the full participation of all learners, including those who use a means of communication other than speech.

For learners whose first language is neither English nor Welsh, schools should take specific action to help them learn both spoken and written English and/or Welsh through the curriculum. Schools should ensure that learners are provided with material that is appropriate to their ability and previous education/experience, and that extends their language development and challenges them cognitively.

Learner entitlement

Schools in Wales should teach all programmes of study and frameworks in ways appropriate to learners' developing maturities and abilities. Schools should ensure that learners' preferred systems of communication are used to maximise access to the curriculum and should recognise the value of the home language in learning. Learners should experience a variety of styles to extend their learning.

To enable **all** learners to access relevant skills, knowledge and understanding at an appropriate level, schools may use content from earlier or later phases/key stages within the curriculum. Schools should present material in ways suitable for the learners' age, experience, understanding and prior achievement to engage them in the learning process.

For learners working **significantly** below the expected levels at any key stage, schools should design their curriculum to meet the priority needs of their learners. Sufficient flexibility exists within the curriculum to meet the needs of **all** learners without the need for disapplication. Where it is not possible to cover all of the programmes of study for each key stage, the statutory requirement to provide a broad, balanced curriculum can be met by using the full range of subjects as contexts for learning.

For learners working at higher levels, greater challenge should be incorporated by presenting material in ways that extend breadth and depth of study. The level of demand may also be increased through the development and application of communication, number, information and communication technology (ICT) and thinking skills across the curriculum.

Schools should choose material (to be covered in depth or in outline) that will:

- provide a meaningful, relevant and motivating curriculum for their learners
- meet the specific needs of their learners and further their all-round development.

Developing skills across the curriculum

A non-statutory Skills Framework has been developed in order to provide guidance about continuity and progression in thinking skills, communication, number and ICT for learners from 3–19.

At Key Stages 2 and 3, learners should be given opportunities to build on skills they have started to acquire and develop at Foundation Phase. Learners should continue to acquire, develop, practise, apply and refine these skills through group and individual tasks in a variety of contexts across the curriculum. Progress can be seen in terms of the refinement of these skills and by their application to tasks that move from: concrete to abstract; simple to complex; personal to the 'big picture'; familiar to unfamiliar; and supported to independent and interdependent.

Thinking 

Learners develop their thinking across the curriculum through the processes of **planning**, **developing** and **reflecting**.

In science, learners follow the cyclical process of planning, developing and reflecting in all areas of Enquiry, through which the range is taught. Focused paired/group work allows such a process to be articulated within lessons so that learning and thinking strategies can be developed and applied to new situations leading to high quality outcomes.

Communication 

Learners develop their communication skills across the curriculum through the skills of **oracy**, **reading**, **writing** and **wider communication**.

In science, learners communicate ideas, information and data in a variety of ways depending on the nature of the task, audience, purpose and the learners' own preferences. Communication can take a wide variety of forms, including the use of IT at times, and with increasing maturity should show progression in the use of scientific terminology, symbols and conventions and a more logical, systematic approach.

ICT

Learners develop their ICT skills across the curriculum by **creating, presenting, finding and developing information and ideas** and by using a wide range of equipment and software.

In science, learners use ICT for a number of purposes. They search for, access, process and analyse relevant scientific ideas, information and data. They use ICT to present their ideas, information and data in the most appropriate form.

Number

Learners develop their number skills across the curriculum by **using mathematical information, calculating, and interpreting and presenting results**.

In science, learners work quantitatively to estimate and measure using non-standard and then standard measures, recording the latter with appropriate S.I. units. They use tables, charts and graphs to record and present information. With increasing maturity they draw lines of best fit on line graphs, use some quantitative definitions and perform scientific calculations.

Curriculum Cymreig and personal and social education across the curriculum

At Key Stages 2 and 3, learners should be given opportunities to build on their experiences at the Foundation Phase and promote their knowledge and understanding of Wales, and their personal and social development and well-being.

Curriculum Cymreig

Learners should be given opportunities to develop and apply their knowledge and understanding of the cultural, economic, environmental, historical and linguistic characteristics of Wales.

Science contributes to the Curriculum Cymreig by the use of contexts that are relevant to learners' lives in Wales. The rich and varied environment around learners gives the basis for fieldwork. Learners have the opportunity to study recycling, sustainability and the impact of humans within their locality and further afield.

Personal and social education

Learners should be given opportunities to promote their health and well-being and moral and spiritual development; to become active citizens and promote sustainable development and global citizenship; and to prepare for lifelong learning.

Science contributes to learners' personal and social education by helping them to make sense of issues within their lives and others' lives. It gives background evidence to health and well-being, sex and relationships, recycling and the sustainability of both materials and energy. With increasing maturity learners compare their lives with that in developing countries and review the impact of humans on the Earth.

Science at Key Stage 2

At Key Stage 2, learners should be given opportunities to build on the skills, knowledge and understanding acquired from the Foundation Phase. They should develop their skills through the range of Independence and interdependence of organisms, The sustainable Earth and How things work. Learners should be taught to relate their scientific skills, knowledge and understanding to applications of science in everyday life. They should be taught to recognise that scientific ideas can be evaluated by means of information gathered from observations and measurements. Teaching should encourage learners to manage their own learning and develop learning and thinking strategies appropriate to their maturity. They should be taught to value others' views and show responsibility as local citizens.

Activities should foster curiosity and creativity and be interesting, enjoyable, relevant and challenging for the learner. They should enable learners to initiate, explore and share ideas, and extend, refine and apply their skills, knowledge and understanding in new situations. They should allow time for thinking, peer discussion and reflection.

Science at Key Stage 3

At Key Stage 3, learners should be given opportunities to build on the skills, knowledge and understanding acquired at Key Stage 2. They should develop their skills through the range of Independence and interdependence of organisms, The sustainable Earth and Energy. Learners should be taught to apply their scientific skills, knowledge and understanding to design strategies, solve problems and offer explanations, relating scientific ideas to the information about them. They should be given opportunities to study the work of scientists and to recognise the role of experimental data, creative thinking and values in their work and in developing scientific ideas. Teaching should encourage learners to manage their own learning and further develop learning and thinking strategies. They should be taught to take different perspectives, value others' opinions and be responsible global citizens.

Activities should foster curiosity and creativity and be interesting, enjoyable, relevant and challenging for the learner. They should enable learners to initiate, explore and share ideas. Activities should enable learners to extend, refine and apply their skills, knowledge and understanding in new and more abstract situations. They should allow time for thinking, peer discussion and reflection.

Skills

Communication

Pupils should be given opportunities to handle and present scientific information to:

1. search for, access and select relevant scientific information, from a range of sources, *e.g. books, media, internet, CD ROMs and DVDs*
2. communicate their work clearly by speech, writing, drawings, diagrams, charts, tables, bar charts, line graphs, videos, and ICT packages, using relevant scientific vocabulary
3. use standard measures and S.I. units *e.g. kg, s, N, m.*

Enquiry

Pupils should be given opportunities to carry out enquiries through the processes of:

Planning

Pupils turn ideas suggested to them, and their own ideas, into a form that can be investigated using enquiry types such as pattern-seeking, exploration, classifying and identifying, making things, fair testing, using and applying models. They outline the planned approach/method recognising, deciding upon and giving some justification for each of the following when appropriate:

1. the choice of success criteria
2. predictions using some previous knowledge, understanding and preliminary work
3. where and how to find relevant information and ideas
4. when carrying out a fair test, the key variables that need to be controlled and how to change the independent variable whilst keeping other key variables the same
5. the observations or measurements that need to be made
6. the equipment and techniques required for the enquiry
7. any hazards and risks to themselves and others.

Developing

Pupils follow the planned approach/method, **revise** it where necessary, and where appropriate:

1. use apparatus and equipment correctly and safely
2. make careful observations and accurate measurements, using digital and ICT equipment at times
3. check observations and measurements by repeating them in order to collect reliable data
4. make comparisons and identify and describe trends or patterns in data and information
5. use some prior knowledge to explain links between cause and effect when concluding
6. consider different interpretations and distinguish between 'facts', beliefs and opinions, giving reasons and begin to recognise bias
7. form considered opinions and make informed decisions.

Reflecting

Pupils think about what they have done in order to consolidate learning and transfer skills, knowledge and understanding to other contexts by:

1. beginning to evaluate outcomes against success criteria
2. deciding whether the approach/method was successful
3. describing any amendments made to the planned approach/method
4. suggesting how the approach/method could have been improved
5. describing how they have learned and identifying the ways that worked the best
6. linking the learning to similar situations, within and outside school.

Range

Independence and interdependence of organisms

Pupils should use their skills, knowledge and understanding to investigate how animals and plants are independent yet rely on each other for survival. They should be given opportunities to study:

1. the names, positions, functions and relative sizes of a human's main organs
2. the need for a variety of foods and exercise for human good health 
3. the effect on the human body of some drugs, *e.g. alcohol, solvents, tobacco* 
4. the plants and animals, *e.g. identification, nutrition, life cycles, place in environment,* found in two local contrasting environments 
5. the interdependence of living organisms in the environments and their representation as food chains 
6. the environmental factors that affect what grows and lives in the environments, *e.g. sunlight, water availability, temperature* 
7. how humans affect the local environment, *e.g. litter, water pollution, noise pollution*. 

The sustainable Earth

Pupils should use their skills, knowledge and understanding to compare the Earth with other planets, investigate materials around them and consider the importance of recycling. They should be given opportunities to study:

1. the daily and annual movements of the Earth and their effect on day and year length
2. the relative positions and key features of the Sun and planets in the solar system
3. a comparison of the features and properties of some natural and made materials, *e.g. wool, water, sugar, salt, cotton, diamond, plastic, glass, paper, rubber*
4. the properties of materials relating to their uses
5. how some materials are formed or produced
6. a consideration of what waste is and what happens to waste that can be recycled and that which cannot be recycled. 

How things work

Pupils should use their skills, knowledge and understanding to investigate everyday things such as toys, musical instruments or electrical devices in terms of the science behind how they work. They should be given opportunity to study:

Electricity – its use in everyday life and its behaviour in simple circuits:

1. the need for a complete conducting circuit for an electrical current to flow and how a switch can break the circuit and so stop the current from flowing
2. how to draw circuit diagrams and construct circuits from such diagrams
3. ways of varying current including changing the power supply and its effect on how things work

Forces – how forces affect movement, *e.g. toy cars, magnets, paper aeroplanes, hot air balloons, space shuttles:*

4. how to compare the size of forces between objects using a forcemeter 
5. that forces on objects act in particular directions and can make things speed up, slow down or change direction
6. that there are different types of forces, such as gravity, magnetic and friction, including air resistance, and their effects on movement

Sound – how sound is produced and changed in some musical instruments, *e.g. drum, guitar, recorder:*

7. how sound is made when objects vibrate
8. how the pitch and volume of sound produced by vibrating objects can be changed
9. that vibrations from sound sources can travel through a variety of objects

Light – how light behaves and how this can be used, *e.g. mirrors, periscopes, shadow puppets:*

10. that light travels from a source in a straight line and that most light falling on a shiny surface is reflected
11. that light cannot pass through some materials and this leads to shadow formation.

Skills

Communication

Pupils should be given opportunities to handle and present scientific information to:

1. search systematically for, process and analyse information for a specific purpose, *e.g. books, media, internet, CD ROMs and DVDs*
2. communicate logically by speech, writing, drawings, diagrams, charts, tables, bar charts, line graphs, videos and ICT packages using a wide range of scientific vocabulary,terms, symbols and conventions

3 work quantitatively, using appropriate mathematical conventions and using S.I. units appropriate to their work, *e.g. kg, s, N, m, J, w.*

Enquiry

Pupils should be given opportunities to carry out enquiries through the processes of:

Planning

Pupils decide on the most suitable type of enquiry to carry out (pattern-seeking, exploration, classifying and identifying, making things, fair testing, using and applying models) and outline the planned approach/method, recognising, deciding upon and justifying each of the following when appropriate:

1. the choice of success criteria
2. predictions using previous knowledge, understanding and preliminary work
3. a range of options as to where and how to find relevant information and ideas
4. when carrying out a fair test, control variables appropriately and identify any variables that cannot readily be controlled
5. the number of observations or measurements that need to be made and their range and values to ensure reliability of evidence
6. the equipment and techniques required for the enquiry
7. any potential hazards in their work.

Developing

Pupils follow the planned approach/method, revise it where necessary, and where appropriate:

1. use a range of apparatus and equipment safely and with skill, taking action to control the risks to themselves and others
2. make sufficient relevant observations and accurate measurements, using ICT at times, to a degree of precision appropriate to the enquiry
3. identify, describe and explain trends, patterns and relationships
4. use scientific prior knowledge to explain links between cause and effect when concluding
5. consider whether there is sufficient information to enable firm conclusions to be drawn, taking account of uncertainties/ anomalies
6. identify and assess bias and reliability
7. consider others' views to inform opinions and decisions.

Reflecting

Pupils think about what they have done in order to consolidate thier learning and transfer skills, knowledge and understand to another context by:

1. evaluating how far outcomes reflect success criteria
2. justifying any improvements made to the planned approach/method
3. identifying the learning/thinking strategies they have used
4. linking the learning to dissimilar but familiar situations, within and outside school.

Range

Independence and interdependence of organisms

Pupils use their skills, knowledge and understanding to investigate how humans are independent yet rely on other organisms for survival applying this to life in countries with different levels of economic development. They should be given opportunities to study:

1. the basic structure and function of some cells, tissues, organs and organ systems and how they support vital life processes
2. how food is used by the body as fuel during respiration and why the components of a balanced diet are needed for good health 
3. the beneficial and detrimental effects of some drugs on the organs of the human body and other consequences of their use, *e.g. insulin, steroids, paracetamol, caffeine* 
4. the interdependence of organisms and their representation as food webs, pyramids of numbers and simple energy-flow diagrams
5. how and why food webs are affected by environmental factors, *e.g. light intensity, water availability, temperature,* and their fluctuations
6. how human activity affects the global environment, *e.g. acid rain, greenhouse effect,* and the measures taken to minimise any negative effects and monitor them, *e.g. by Earth observation satellites* 
7. applications of science, medicine and technology that are used to improve health and the quality of life, including those in countries with different levels of economic development.

The sustainable Earth

Pupils use their skills, knowledge and understanding of the materials in the Earth and its atmosphere and how they can change, and apply these in contemporary contexts. They should be given opportunities to study:

1. the properties of solids, liquids and gases and how the particle model can be used to explain these properties
2 the physical and chemical properties of some elements, compounds and mixtures and how mixtures can be separated by simple techniques
3. the differences between physical and chemical changes using some common examples
4. investigations into the patterns of behaviour of elements and compounds and their use to describe and predict their behaviour in chemical reactions
5. the properties of sustainable materials and how these are related to their uses in everyday life, *e.g. in the construction and manufacturing industries,* and the importance of sustainability. 

Energy

Pupils use their skills, knowledge and understanding of the ways in which energy is used in a range of contemporary devices and the advantages and disadvantages of different energy resources to evaluate future energy possibilities. They should be given opportunities to study:

1. the behaviour of current in electrical circuits by investigation
2. the conservation of energy and its availability as a resource
3. a range of familiar devices/machines and their use of energy transfer including those involving electromagnetic radiation, heat, sound, electricity and mechanical work, *e.g. hairdryer, mobile phone, skateboard, car, solar cells*
4. ways in which energy can be stored including chemical energy in fuels, kinetic and potential energy, and the internal energy of objects

5 mechanical energy, being described as the work done and power as a measure of the rate of doing work

6 how renewable and non-renewable energy resources are used to generate electricity and the implications of decisions made about their use

7. a review of technologies under development, which may lead to more efficient use of, or alternative, energy resources, *e.g. hydrogen powered cars, using cooking oil/gasohol as replacements for diesel/petrol.*

National curriculum outcomes

The following national curriculum outcomes are non-statutory. They have been written to recognise the attainment of pupils working below Level 1. National curriculum outcomes 1, 2 and 3 align with the Foundation Phase outcomes 1, 2 and 3.

The national curriculum outcomes describe the types and range of performance that pupils working at a particular outcome should characteristically demonstrate. In deciding on a pupil's outcome of attainment at the end of a key stage, teachers should judge which description best fits the pupil's performance. Each description should be considered in conjunction with the descriptions for adjacent outcomes.

Outcome 1

Pupils explore their immediate and familiar environment and use words, signs or symbols to communicate their observations. They recognise themselves and familiar people in pictures and stories and show knowledge of daily routines. Pupils begin to use basic tools and assemble familiar resources.

Outcome 2

Pupils begin to group objects together, recognising similar characteristics. They handle and explore the use of a range of tools and materials safely to make simple constructions. Pupils make straightforward choices and respond to questions (what, where) about recent events and familiar stories. They offer their own ideas, sometimes making connections to earlier experiences. Pupils begin to match specific activities to certain times of day or week and show some appreciation of differences between present and past. They gain confidence in finding their way in familiar surroundings, developing knowledge of roles of familiar people in school and the local community.

Outcome 3

Pupils sort objects and materials according to simple criteria, and with help safely cut, shape and assemble these to make simple products that are meaningful to them. They communicate their developing knowledge of items in everyday use and often ask 'how' and 'why?'. Pupils may suggest where to find information and begin to record their observations and intentions using symbols, pictures, drawings or simple phrases. They take part in the planning of future activities and begin to make predictions by thinking about and talking through earlier experiences. Through enquiry, pupils are able to identify changes in their environment and in materials, natural features, pictures and artefacts. They are able to follow simple instructions and sequence events in stories and creative activities. Pupils are beginning to use everyday terms about their surroundings and the passing of time, remembering significant events in the past and anticipating events in the future.

Level descriptions

The following level descriptions describe the types and range of performance that pupils working at a particular level should characteristically demonstrate. In deciding on a pupil's level of attainment at the end of a key stage, teachers should judge which description best fits the pupil's performance. Each description should be considered in conjunction with the descriptions for adjacent levels.

By the end of Key Stage 2, the performance of the great majority of pupils should be within the range of Levels 2 to 5, and by the end of Key Stage 3 within the range 3 to 7. Level 8 is available for very able pupils and, to help teachers differentiate exceptional performance at Key Stage 3, a description above Level 8 is provided.

Level 1

Pupils listen and respond to scientific ideas and react appropriately. They take part in simple activities and through a variety of play experiences explore the world around them. They observe and describe simple features of organisms, objects, materials and events through talking, drawing, mark making or simple words. They recognise and name a range of common organisms, objects, materials, light sources and sound sources.

Level 2

Pupils talk about the steps needed to carry out their enquiries and what is needed to be successful. They choose from given options where to find information and ideas, including ICT sources.

They make enough observations to be able to sort, group and compare organisms, objects, materials, and events. They make simple records of their observations, ideas or findings by talking, drawing, writing simple sentences, tally charts or pictograms. They describe the basis for their groupings using simple differences between organisms, objects, materials and physical phenomena.

They respond to questions about what worked and what didn't.

Level 3

Pupils talk about their ideas and using their everyday experience they make simple predictions. They plan, with support, the method to be used for their enquiries. They suggest where to find information and ideas, including ICT sources. When appropriate, they agree on some simple success criteria.

They follow a simple series of instructions safely to gather their findings. They make observations that they could measure using simple equipment. Where relevant, they display their observations, ideas or findings in a given format, such as a simple table or a bar chart. They give an explanation, based upon their everyday experiences, for their findings and any simple patterns in their findings. They give simple explanations for differences between and changes to organisms, objects, materials and physical phenomena. When considering evidence, information and ideas they begin to

distinguish between scientific 'facts', beliefs and opinions and make their own decisions by weighing up pros and cons.

They link outcomes to success criteria and identify what worked and what didn't, beginning to think about how the method could be improved. They link the learning, with support, to familiar situations.

Level 4

Pupils begin to recognise the different enquiry types. They use some scientific knowledge and skills to predict outcomes and plan their enquiries. In a fair test enquiry, they recognise, with support, the variables to change and measure and those to be kept the same. They find and use a variety of information sources, including ICT. They decide upon success criteria.

They follow the planned method safely making amendments where necessary. They observe and measure using standard measuring equipment within a given range using S.I. units. They record their observations, ideas or findings in tables and bar charts and can plot a line graph when the axes and scales are given, using ICT at times. They identify patterns and trends. They use some scientific knowledge and understanding to explain their findings, differences between, and changes to organisms, materials and physical phenomena. When considering different interpretations, they distinguish between 'facts', beliefs and opinions and begin to recognise bias. They form considered opinions and make informed decisions. They organise and communicate their findings using relevant scientific language.

They decide whether their method was successful by referring to their success criteria and say how they could improve it. They describe how they have learned and identify the ways that worked the best. They link their learning to similar situations.

Level 5

Pupils identify and plan an appropriate enquiry type. They make predictions based on scientific knowledge and understanding, including simple models. When planning a fair test, they identify key variables and distinguish between independent and dependent variables and those that they will keep the same. They find and use relevant information and ideas, including ICT. They give some justification for their success criteria.

When appropriate they start to make decisions about the range and values of the independent variable and select measuring instruments that allow them to make a series of measurements accurately and with precision. They work safely and regularly check progress, revising the method where necessary. They record their observations and measurements systematically, using S.I units where appropriate, and start to consider the reliability of their findings. They select the most appropriate type of graph or chart to display data. They identify patterns and trends and describe relationships between two continuous variables. They use scientific knowledge and understanding, including simple models, to explain their findings and any differences between, or changes to organisms, materials and physical phenomena. They draw conclusions that are consistent with their findings. When considering evidence, information and ideas they identify and assess bias and consider others' views to inform opinions and decisions. They organise and communicate their findings, integrating different forms in various presentations.

They begin to evaluate how far success criteria fully reflect successful outcomes. They identify the learning/thinking strategy they have used and link learning to dissimilar but familiar contexts.

Level 6

Pupils suggest a variety of methods or strategies. They make predictions using abstract scientific models. In a fair test enquiry, they plan how to control the variables that they need to keep the same. They justify their choice of success criteria.

They make precise observations and measure accurately using equipment with fine divisions, recognising that they could use ICT to collect better quality data. They use appropriate axes and scales for graphs to show data effectively. They offer some explanations for any anomalous results. They explain their findings, draw conclusions that are consistent with their findings and begin to explain to what extent their findings are consistent with scientific knowledge and understanding, including abstract scientific models. They recognise that a number of factors may have to be considered when explaining changes. They regularly check progress, make ongoing revisions when necessary and begin to justify any amendments or improvements made. They organise and communicate their findings in a variety of ways fit for purpose and audience.

They evaluate how far success criteria fully reflect successful outcomes. They link the learning to more abstract situations and identify the learning/thinking strategies being used.

Level 7

Pupils justify the methods and strategies they use. They make qualitative predictions using linked scientific knowledge and understanding gained from a variety of sources. They identify key variables in complex contexts and those that may not be readily controlled explaining why this is the case.

They systematically observe and measure. They justify any amendments made to the method/strategy. They use some quantitative definitions and perform calculations using the correct units. They draw conclusions that are consistent with their findings and explain to what extent findings are consistent with scientific knowledge and understanding. They describe how they might collect more information in order to check the validity of their conclusions. In explanations they apply abstract models and make links between systems. They begin to use their explanations to make predictions. They review their strategies in light of results obtained or the information gathered. They begin to evaluate evidence, information and ideas in order to gauge bias, reliability and validity. They take different perspectives to inform opinions and decisions. They communicate evidence in a variety of ways for a variety of purposes.

They refine success criteria in the light of experience for future occasions.

Level 8

Pupils justify their method/strategy in view of the reliability of data and/or the information to be gathered and the accuracy of the equipment to be used. They identify any possible problems with the strategy. They make quantitative predictions, where appropriate, using detailed scientific knowledge and abstract modelling.

They use complex abstract models or combinations of models/systems to explain findings and draw conclusions. They explain the impact of one system on another. They evaluate evidence, information and ideas in order to gauge levels of bias, reliability and validity. They draw conclusions showing an awareness of the degree of uncertainty and a range of views. They identify and explore uncertainties and explain anomalies.

They suggest alternative learning/thinking strategies and link learning to make further predictions.

Exceptional Performance

Pupils justify their method/strategy making multiple links to prior learning and independent research and taking account of possible problems. They justify their predictions by making multiple links between scientific models, theories and systems.

They develop an organised system to record evidence and track changes in more than one dependent variable, clearly conveying points of particular interest. They use their knowledge and understanding to critically evaluate predicted effects on systems. They use detailed evidence to form consistent conclusions/opinions.

They evaluate the likely effectiveness of alternative strategies and refine learning/thinking strategies for future occasions.

At Key Stage 4, learners should be given opportunities to build on the skills, knowledge and understanding acquired at Key Stage 3. They should learn about the way that science and scientists work within society. They consider the relationship between data, evidence, theories and explanations and develop their practical, problem-solving and enquiry skills, working individually and in groups. They evaluate enquiry methods and conclusions both qualitatively and quantitatively, and communicate their ideas with clarity and precision. Learners develop their ability to relate their understanding of science to their own and others; decisions about lifestyles, and to scientific and technological developments in society. Activities should promote peer discussion and reflection when thinking about tasks and problems, in deciding about approaches, and in revising them. Some activities should help learners consolidate their own learning through applying their skills and knowledge in other contexts and situations.

Learning Pathways 14–19

For learners at Key Stage 4, science will be part of each individual's learning pathway. The course of study followed should be designed to encourage both the abilities of young people as learners and their desire to access future learning opportunities. In particular, the course should contribute as widely as possible to the four aspects of learning as identified in the 14–19 Learning Core.

Skills

Communication skills

Pupils should be given opportunities to:

1. recall, analyse, interpret, apply and question scientific information or ideas
2. use both qualitative and quantitative approaches
3 present information, develop an argument and draw a conclusion, using scientific, technical and mathematical language, conventions and symbols and ICT tools.

Enquiry and practical skills

Pupils should be given opportunities to:

1. plan to test a scientific idea, answer a scientific question, or solve a scientific problem
2. collect data from primary or secondary sources, including using ICT sources and tools
3. work accurately and safely, individually and with others, when collecting first-hand data
4. evaluate methods of collection of data and consider their validity and reliability as evidence.

Data, evidence, theories and explanations – links between ideas and information in science.

Pupils should be given opportunities to:

1. explore how scientific data can be collected and analysed, and how interpretation of data, using creative thought, provides evidence to test ideas and develop theories
2. appreciate how explanations of many phenomena can be developed using scientific theories, models and ideas
3. recognise that scientific knowledge changes over time, and that there are some questions that science cannot currently answer or address.

Range

Pupils should build on their previous experiences and be taught within the context of the skills section. They should have particular regard to:

- scientific enquiry
- scientific and technological developments, their benefits, drawbacks and risks
- ethical, social, economic and environmental issues and their interaction with science.

Organisms and health

1. Organisms are interdependent and adapted to their environments.
2. Variation within species can lead to evolutionary changes and similarities and differences between species can be measured and classified.
3. The ways in which organisms function are related to the genes in their cells.
4. Chemical and electrical signals enable body systems to respond to internal and external changes, in order to maintain the body in an optimal state.
5. Human health is affected by a range of environmental and inherited factors, by the use and misuse of drugs and by medical treatments.

Chemical and material behaviour

1. Chemical change takes place by the rearrangement of atoms in substances
2. There are patterns in the chemical reactions between substances.
3. New materials are made from natural resources by chemical reactions.
4. The properties of a material determine its uses.

Environment, Earth and universe

1. The effects of human activity on the environment can be assessed using living and non-living indicators.
2. The surface and the atmosphere of the Earth have changed since the Earth's origin and are changing at present.
3. The solar system is part of the universe, which has changed since its origin and continues to show long-term changes.

Energy, electricity and radiations

1. Energy transfers can be measured and their efficiency calculated, which is important in considering the economic costs and environmental effects of energy use.
2. Electrical power is readily transferred and controlled, and can be used in a range of different situations.
3. Radiations, including ionising radiations, can transfer energy.
4. Radiations, in the form of waves can be used for communication.