

Science Working Group

Science for Ages 5-16 An excerpt from the report of the National Curriculum Science Working Group*

Outline

5.1 This Chapter presents our recommendations for the technology curriculum 5 to 11 in detail. It sets out the four attainment targets we recommend for the 5 to 7 key stage and the 7 to 11 key stage, together with the relevant parts of the Programme of Study which are associated with those attainment targets. Also associated with each attainment which set out what each pupil will be expected to know, understand and do in order to have reached that level. The corresponding TGAT levels are placed on the right of the statements of attainment in the spread sheets. The four attainment targets for each key stage are grouped into one profile component.

5.2 As with Science we have used certain terms in our statements of attainment concerning knowledge and understanding. The meaning we attach to these terms are repeated below:

'Know that' means that recall is expected.

'Know about' means that a generalised awareness of a subject is expected, without necessarily having detailed recall. This more generalised knowledge can be focused through different contexts.

'Understand' means that a pupil is able to apply and use knowledge in new, given situations.

5.3 But before turning to our recommendations for Technology in detail we believe it may be useful to explain our understanding of Technology and its place in the primary curriculum because it is only recently that it has begun to become established.

Technology in primary schools

5.4 Some aspects of Technology have always been present in primary schools, mainly in practical activities in Science, Mathematics and Craft. As teachers have developed a way of working through themes and topics, which is unrestricted by subject boundaries, they have often introduced aspects of Technology in problem solving, without necessarily using the term, or understanding the whole process. Some teachers are helping children undertake worthwhile practical activities which are

not technological; others concentrate on one aspect of technology only, whilst a growing number are undertaking a range of technological activities, sharing their ideas and expertise with others.

5.5 This curriculum area is growing and developing in primary schools, but as yet there is no wide agreement among teachers as to what it should constitute in terms of primary practice. Despite several valuable national and local initiatives, it will still be some time before it settles into its place in primary schools as a whole, and we recognise the need for research and development in this area over the next few years.

5.6 Our views on Technology 5 to 11 are based on the good practice now developing in some schools. They take into account that there are many primary classes where this work has yet to begin with primary children, and others where this work has yet to begin with primary children, and others where able teachers, with and without appropriate resources, are helping their children to achieve very high standards.

5.7 In describing our framework we have tried to strike a balance between using the language of technology and using terms which will be more readily understood, so that those unfamiliar with technological language will not be deterred. As teachers and children work in this area and begin to gain familiarity with the language and processes of technology, they should grow in confidence and generate a mutual enthusiasm, helping to build up good primary practice in the future.

5.8 Much of children's early technological experience comes from solving problems and responding to the needs created by their imaginative play. They may need to cross a stream,* build a den, climb a wall or sail a boat. To do this they need to arrange and order things around them to create desired structures. They will use materials which are to hand and begin to find out about them, choosing them to suit a purpose, fixing them, modifying them. They will learn about these structures, how to make them stable, and by the process of trial and error, seek to control or improve their world. These activities provide a range of experiences which can

be harnessed and developed by the teacher within the classroom.

5.9 At the primary stage, children learn about the world around them mainly through first-hand experience and with the help of teachers develop important skills, concepts and attitudes. They do not see the boundaries between one form of knowledge and another. Since Technology drawn from many areas of the curriculum and uses the knowledge and understanding it needs from them to solve problems, it fits quite appropriately into the primary classroom. Thus:

- children making a series of houses to defy the efforts of the wolf to blow them down will need to know something about materials used for building and ways of fixing them to make strong structures;
- children building a Norman castle will need to know something about the Norman's way of life and the problem of that period in history to help them understand why the Normans built castles as they did and used the methods they did. This will help the children make realistic models;
- after watching a parachute drop, a group of children could develop their own parachute, and explore, for example, different materials and canopy design;
- through Geography, children will begin to see how people use and adapt their environment and build effective homes or shelters using local materials. They will find out how people move around, transport their goods and materials, and how they trade;
- through Physical Education they will be involved in activities of balancing, bending and twisting, they will begin to feel the forces involved, and relate these to work in other areas;
- through Mathematics, they will learn about some of the two- and three-dimensional shapes they are using, how precision of measurement of length and angle matters, and the importance of scale.

5.10 As problems are identified and solutions sought, children will be able to draw from a wide range of experiences, of which some will have been guided by the teacher, some will have been shared

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with others and some drawn from other sources such as television.

What is Technology?

5.11 From the wide range of valuable activities in primary classrooms, it is useful to draw out some of the features which characterise technological activity:

- it is concerned with practical problem-solving to meet a purpose or respond to a need;
- it is concerned with designing and making;
- it draws on a wide variety of experiences, knowledge and skills from many subject areas;
- it involves the need to investigate, innovate, make and evaluate;
- it can involve designing a system and putting it into effect;
- it is concerned with open-ended problems which are capable of having more than one solution;
- It is concerned with optimum rather than correct solutions, and allows children to express their own views and preferences.

5.12 Since Technology involves practical solutions to problems, it is mainly associated with the knowledge and skills of Craft and Design, Economics, Mathematics and Science.

From **Craft and Design** it draws on knowledge of:

- materials and the way they can be worked;
- tools, and methods of use and safety;
- aesthetic factors (including effects of colour, pattern and texture);
- the ability to communicate design ideas.

From **Economics** it draws on ideas which become very important at a later stage:

- consideration of availability of materials;
- consideration of the cost of the materials and the process used and the time taken;
- consideration of the value of the project in view of the compromises which have to be made.

From **Mathematics** it draws on:

- knowledge and understanding of shapes - Both two- and three-dimensional;
- spatial awareness;

- the need and ability to estimate, compute and measure;
- the ability to use scale.

From **Science** it draws mainly on:

- skills of exploration and investigation;
- skills of exploration and investigation;
- materials and their properties;
- forces and structures;
- energy and the way it is controlled;
- knowledge and understanding, including living things, which can provide the context of much technological activity.

Technology and Science

5.13 Technology and Science are closely linked and many teachers have come to Technology through activities they regard as practical Science. There are however distinct differences. Because Science is enquiry-led and discovery is for its own sake; the conclusions are drawn from the evidence and data and are as objective as possible. Technology, on the other hand, essentially involves meeting a need or solving a problem. The best solution will often involve a subjective judgement, and will be arrived at after taking a wide range of factors into account.

5.14 A summary of Technology which may be helpful is:

'Technology involves a creative human activity which brings about desired changes by making things, controlling things or making things work better by careful designing and making, using relevant knowledge and resources.'

Processes supporting technological activities

5.15 Technology is not the only way of solving a practical problem; the solution is technological if it involves designing and making something.

5.16 In this process children need to understand

the needs of others

eg before you design and make something to improve a blind person's life, you need to know about the problems of blindness; or before you decide to attract birds to build nests in your garden, you need to know about the habitat and behaviour of the birds you wish to attract; and

The use of structure and materials

eg before you design and make a device to lift and move a heavy object, you need to understand that when materials are assembled in a particular way they are capable of lifting and moving heavy loads. Moreover there are alternatives. Some may design a system which involves the use of lever and rollers, some a block and tackle and others may design a crane.

5.17 As children develop their technological capabilities, they need to develop their awareness, capability and understanding, all of which are closely inter-related.

5.18 Children should be given the opportunity to study the results of Technology and the solutions which other people have found to problems. They should see how human ingenuity and innovation have resulted in some surprising solutions to problems. They should have the opportunity to observe how each generation or group has improved that solution, refining it in the light of changing need. Thus:

- before designing and building a tunnel under the Channel, however great the need, you should realise that it will have strong implications for the whole social structure and ecology of the local environment, patterns of transport, jobs and many other issues which will need to be considered. Children need to learn to develop their judgements on the results of Technology, both on its benefits and its drawbacks.

5.19 Children will begin to understand that there are a number of approaches to solving problems. Whichever approach is used it is expected that the process will show evidence of:

(i) Observation, investigation and enquiry

These will arise naturally as children explore the context of their problem, decide what needs to be done and what conditions need to be met. A sharing of such findings with others helps to broaden the understanding and widen the range of solutions that could be explored; children may in this way learn to modify their ideas.

(ii) Recording

Children should be encouraged to

record the outcomes of their observations as a first step towards developing a solution. This may involve drawing or writing or the use of other media such as tape recordings or photographs. Such records help children form hypotheses and promote imaginative and inventive solutions to their problems. Discussion of this material with others again plays an important role.

(iii) Designing

From their recorded observations children explore possible solutions to their problem and, as these ideas clarify, so they are considered, discussed, refined or rejected until one is selected for development. They then decide how and with what it will be made. This is the beginning of technological design and it can be a short or long process.

(iv) Making

From the preliminary design stage children plan how they will interpret their designs into three-dimensional forms. During this 'making' process their design may need to be modified or others added. At this stage the children aim to produce models or artefacts which attempt to find a solution to the original problem, but in doing so they come to recognise how aesthetic considerations of quality and appearance affect their solution.

(v) Evaluating

Children should evaluate the outcome to see if it satisfies the original intention.

The results of technological activities

5.20 The work which children undertake in Technology will be broad and varied. They may result in, for example,

- a dragon made from scrap material which roars and which has flashing eyes;
- a model crane like the one they saw on a visit to the docks;
- a device to feed the goldfish whilst children are away on holiday.

On the way to achieving their solution, the children may have experience of:

- investigating ways of making a switch;
- designing a pulley system;

- investigating the control, timing and methods of delivering food.

5.21 Technological solutions have to 'work', ie satisfy the original problem, and one assess the outcome therefore is to encourage children to ask themselves

- does the solution work?
- have I accomplished what I set out to do?
- could I make it work better?
- have I used the most appropriate materials?
- is it aesthetically pleasing?
- have I considered such factors as cost and time taken?
- why does it work?
- what helped me when designing it?
- how did I overcome any difficult parts of the design?

5.22 As children gain in experience so they will refine their thinking and develop their making skills. They will be able to tackle more complex problems and produce solutions which show a developing awareness of aesthetic qualities, manipulative and communicating skills. They will begin to develop a deeper understanding of the world, their culture and how it developed. This should give them experience and confidence to handle uncertainty and make them feel able to tackle and solve today's problems and live in tomorrow's world.

The framework for our recommendation

5.23 From this background we have drawn four essential strands:

- Technology in context
- Designing and Making
- Using Forces and Energy
- Communicating Technology

Each of these plays an important part in the whole process. They will not, however, always be present in the same proportion all the time by the very nature of the diversity of the problems being tackled and the capability of children involved. But we recommend them as the four attainment targets which make up the one Profile Component, Technology 5 to 11. Details are set in the spread sheets which follow.

Technology in context

Attainment Target 1

Children should know that the response to the needs of the living and man-made world has often resulted in a technological solution. They should understand that there can be benefits and drawbacks, and realise that this has implications for their own lives, that of the community and the way we make decisions.

Relevant Part of the Programme of Study

5 to 7 Children should be given the opportunity to develop an awareness and understanding of the needs of the living and man-made world (for example, food, water, shelter, transport and medical care) through a range of everyday, personal and imaginative contexts, and recognise the advantages and disadvantages of different solutions.

7 to 11 Children should develop a growing awareness and understanding of technological solutions to problems both in historical and modern contexts. This can be done through a range of themes, topics, visits or everyday situations giving children the opportunity to study solutions such as:

- a range of solutions from everyday products to major engineering works such as castles, bridges, canals or docks;
- those involved in growing plants for food or pleasure, keeping animals at home, school, on farms or in zoos;
- technological systems involved in manufacturing common foods, (for example, bread, dairy products) and how they are prepared for consumption;
- systems for controlling traffic flow, moving products or people;
- successful solutions to similar problems, such as things that fly, dig, move on land, in air or through water, support tall structures, cut tough material;
- technology in the context of disease and its potential to reduce the effects of physical disability.

They should be encouraged to appreciate that the solution to one problem may result in causing another.

Statements of Attainment

Children should:

- know that a problem can have more than one solution.
- be able to identify a need which requires a simple technological solution.
- be able to suggest solutions which show that they are aware of advantages and disadvantages proposed.
- know how the basic needs of life (food, water, transport, communication) have been solved by people, animals and plants.
- be able to distinguish similarities and differences within a group of successful solutions to similar problems (man-made and natural).
- be able to give reasons for the choice of design and the materials used when considering technological solutions, products or systems.
- be able to appraise products or systems from an industrial, agricultural or commercial setting.

Level

1

2

3

4

5

They should have the opportunity to work with them in a variety of situations

- folding, bending, twisting, cutting, joining and altering the surface (painting or sticking things on it).

7 to 11 Children should be given the opportunity to experience a wider range of designing and making activities through which they can develop a growing technological capability. They should experience and show evidence of identifying tasks which require a technological solution; observing, collecting information or data, and investigating that which they consider useful; putting forward solutions, selecting and modifying where necessary, taking account of constraints; making their final solution. They should test it and evaluate it and be able to communicate what they have done in an appropriate form.

They should have the opportunity to handle a wider range of natural and man-made materials, both flexible and rigid, and tools to work them (shape, hold, cut, join). They should use these materials to build structures, working models or other artefacts which give pleasure and/or satisfaction when tackling a specific problem.

They should be encouraged to relate the physical properties of the materials to the uses to which they may be put.

They should have the opportunity to experience the designing and implementing of a system such as a production line, taking account of economic factors, for example, cost and time.

- be able to modify their design or make adjustment where necessary.
- be able to select from a range of everyday materials those which are most appropriate for what they intend to do or the visual effect they want to achieve.
- be able to use hand tools safely, to cut and join appropriate everyday materials; use simple adhesives.

- be able to investigate the context of the task and extend their knowledge where necessary.
- be able to select and use pliable and rigid materials appropriately when building structures, working models or artefacts.
- show that they have considered the appearance as well as the working efficiency of their artefact when evaluating their solution.

- be able to select and use a range of materials to build a variety of standing and moving structures.
- be able to measure and cut a range of materials with some accuracy.

- be able to recognise the need for relevant background information and be able to apply it.

- be able to observe, identify, investigate and collect information or data which is useful.

- be able to recognise deterioration caused by constant use or environmental factors and suggest simple ways to prevent it, (for example, treating the surface).

- be able to test and evaluate their solution against their original needs.

- be able to design and make an artefact which shows an increasing quality in the finished product which should be aesthetically pleasing as well as functionally sound.
- be able to suggest modifications which might improve the overall effect achieved.
- be able to identify and select appropriate materials for a specific task.

3

4

5

**Designing and making
Attainment Target 2**

Children should be able to design and make an artefact, product or system. They should be able to select and use materials to match specific needs; be able to use tools safely to cut, join and mould them with due regard to aesthetic and functional properties.

Relevant Part of the Programme of Study

5 to 7 They should be given the opportunity to experience a wide range of designing and making activities, using a variety of materials. They should be involved in investigating, planning, designing, making, modifying and evaluating with appropriate guidance. They should develop or acquire further knowledge and skills when needed.

They should have the opportunity to handle a wide range of everyday materials, both natural and man-made, investigating similarities and differences whilst exploring their physical and aesthetic properties.

Statements of Attainment

Children should:

- be able to design and make simple artefacts related to the context of the classroom or their lives.
- be able to choose the most suitable material from a given range and give reasons for their choice.
- be able to handle simple tools carefully and safely, (for example, scissors), when cutting and joining easily worked materials into desired shapes.
- be able to solve a problem by designing and making an artefact in a context relevant to their lives.

Level

1

2

- be able to use protective finishes in an aesthetic way.
- be able to use a wider range of hand tools safely, to fashion materials using techniques of construction.

Using forces and energy

Attainment Target 3

Children should be able to develop and use their knowledge and understanding of forces — both static (in structures) and dynamic (in moving things). They should develop and use their knowledge and understanding of energy, its sources, uses and ways of controlling it.

Relevant part of the Programme of Study

5 to 7 Children should be given the opportunity to create structures and engage in activities which enable them to experience pull, push, twist and balance.

They should be involved in constructional activities which enable them to make things move and stop them moving; explore a variety of mechanisms including toys and equipment; and use simple devices such as wheels and rollers.

They should play with and investigate familiar objects (including toys) where energy is stored, controlled and released; gain insight into the forces resulting from using water, weights, sand, wind and themselves as energy sources.

7 to 11 Children should be involved in a range of practical activities which help them to experience and take account of forces such as tension, compression, torsion, bending, friction and gravity.

They should experience a wider range of energy sources including magnetic and electrical. They should be given the opportunity to explore and use levers, cranks, gears and pulleys. They should experience the possibilities of the inclined plane, hydraulic, pneumatic, magnetic and electrical devices.

Their work should also include the use of information technology for storing, processing information and controlling energy (such as moving a buggy-vehicle or working a lighting system).

Statements of Attainment

Children should be able to:

- use forces to push, pull and twist in order to move devices.
- build a variety of structures from everyday materials.
- construct something and make it move.

- make structures which show they have taken into account simple forces to pull, push, twist, bend and balance.
- recognise two energy sources and use one of them to make a device move.

- take into account where friction needs to be increased to provide grip or reduced to make things move more easily.
- modify a structure to take account of increasing forces acting on it.

- select from a variety of energy sources and use it to make a device move.
- control the energy flow using simple devices.
- use triangulation to make a structure more rigid.
- use devices such as gears and pulleys to achieve movement at a desired speed.
- use a range of energy sources knowing when they are appropriate.
- use electrical, magnetic and mechanical methods to control the flow of energy.
- use a computer to store, process or control information.
- make structures showing they have considered the size, shape and material from which they have made it to withstand forces.
- select and use a mechanism from a variety of alternatives to change direction or speed of movement within a device.
- select and use appropriate energy sources and control them using mechanical, hydraulic, pneumatic or electrical devices (including computer control).

Communicating Technology

Attainment Target 4

Children should be able to communicate clearly their stages of thinking, designing and making and

Level

1

evaluating using a variety of means such as modelling, drawing, oral or written, mathematical or computer techniques. They should be able to select the most appropriate method for the audience or purpose.

Relevant Part of the Programme of Study

5 to 7 Children should be given the opportunity when designing and making to develop and use a variety of communication skills and techniques (talking, listening, discussing, writing, drawing, or modelling).

These activities should allow them to become familiar with more precise technical terms, using them to tell others what they have done and what they are going to do, with reasons for their choices.

They should have opportunities for asking questions, seeking answers, discussing and evaluating their ideas with their teacher and other pupils.

7 to 11 They should develop an increasing competence to talk and write about their activities, what they found out, observed investigated or made, representing their ideas through drawings and diagrams where appropriate. They should develop the ability to translate two-dimensional drawings or plans into three-dimensional shapes.

They should be encouraged increasingly to select the form of communication most suitable for the material to be communicated and the audience who will receive it.

They should experience the use of a computer for word processing, and data handling. They should have the opportunity to use a computer to monitor aspects of change in the environment (such as temperature or animal behaviour).

Statements of Attainment

children should be able to:

- talk about what they have done.
- represent what they have done by a combination of drawing and modelling.
- explain what they have done in sequence.
- use drawings and notes where appropriate to help communicate

Level

1

2

the thinking behind their final artefact.

- communicate, using appropriate vocabulary, what they have done and their thinking, planning and making. They should give reasons for any modifications.
- take part in discussions about a design problem, generating and sharing ideas.
- use a simple data base to store, retrieve and use information for designing.

- communicate in an appropriate way the process by which they arrived at the final artefact.
- discuss the planning and ideas which were rejected as well as accepted.
- show how they may have redesigned or remade parts.
- use IT techniques to help when designing.

- receive and exploit ideas from a variety of sources.
- communicate ideas for the solution of problems using appropriate vocabulary, graphical techniques, flow diagrams, and two- or three-dimensional modelling.
- use a computer to monitor information about change in the environment

F Appendix

The Programme of Study for Technology 5 to 11

1. The Programme of Study which follows is divided into two key stages for ages 5 to 7, and 7 to 11.
2. Within the key stages we
 - i. show how the skills of designing and making, and communicating technology should be developed through the programme;
 - ii. identify areas of knowledge which children will need if they are to progress in Technology; and
 - iii. highlight the need to develop technological awareness and understanding leading to the solution of problems both in their historical and contemporary contexts.
3. The Programme of Study consists of a series of statements about what

pupils should be given the opportunity to do. These statements relate to a particular attainment target. Sometimes a number of statements relate to one attainment target. At the end of the last applicable statement we give a reference to the relevant attainment target. As with the Programmes of Study for Science, a reference to AT 2 indicates that the statements relate to Attainment Target 2.

The Programme of Study Technology 5 to 7

Children should:

be given the opportunity to develop an awareness and understanding of the needs of the living and man-made world (for example food, water, shelter, transport and medical care) through a range of everyday, personal and imaginative contexts, and recognises the advantages and disadvantages in meeting needs.

AT1

be given the opportunity to experience a wide range of designing and making activities, using a variety of materials. They should be involved in investigating, planning, designing, making, modifying and evaluating with appropriate guidance. They should develop or acquire further knowledge and skills when needed.

have the opportunity to handle a wide range of everyday materials, both natural and man-made, investigating similarities and differences whilst exploring their physical and aesthetic properties.

have the opportunity to work with them in a variety of situations — folding, bending, twisting, cutting, joining and altering the surface (painting or sticking things on it).

AT2

have the opportunity to create structures and engage in activities which enable them to experience pull, push, twist and balance.

be involved in constructional activities which enable them to make things move and stop them moving, explore a variety of mechanisms including toys and equipment; and use simple devices such as wheels and rollers.

play with and investigate familiar objects (including toys) where energy is stored, controlled and released; gain insight into the forces resulting from using water, weights, sand, wind and themselves as energy sources.

AT3

be given the opportunity when designing and making to develop and use a variety of communication skills and techniques (talking, listening, discussing, writing, drawing or modelling).

using these activities, become familiar with more precise technical terms, using them to tell others what they have done and what they are going to do, with reasons for their choices.

have opportunities for asking questions, seeking answers, discussing and evaluating their ideas with their teacher and other pupils.

AT4

Programme of Study Technology 7 to 11

Children should:

develop a growing awareness and understanding of technological solutions to problems both in historical and modern contexts. This can be done through a range of themes, topics, visits or everyday situations giving children the opportunity to study solutions such as:

- a range of solutions from everyday products to major engineering works such as castles, bridges, canals or docks;
- technology involved in growing plans for food or pleasure, keeping animals at home, school, on farms or in zoos;
- technological systems involved in manufacturing common foods (bread and dairy products) and how they are prepared for consumption;
- systems for controlling traffic flow, moving products or people;
- successful solutions to similar problems, such as things that fly, dig, move on land, in air or through water, support tall structures, cut tough material;
- technology in the context of disease and its potential to reduce the effects of physical disability.

be encouraged to appreciate that the solution to one problem may result in causing another.

AT1

be given the opportunity to experience a wider range of designing and making activities through which they can develop a growing technological capability. They should experience and show evidence of identifying tasks which require a technological solution; observing, collecting information or data, and investigating that which they consider useful; putting forward solutions, selecting and modifying where necessary, taking account of constraints; make their final solution. They should test it and evaluate it and be able to communicate what they have done in an appropriate form.

have the opportunity to handle a wider range of natural and man-made materials, both flexible and rigid, and tools to work them (shape, hold, cut, join). They should use these materials to build structures, working models or other artefacts which give pleasure and/or satisfaction when tackling a specific problem.

be encouraged to relate the physical properties of the materials to the uses to which they may be put.

have the opportunity to experience the designing and implementing of a system such as a production line, taking account of economic factors (for example, cost in time).

AT2

be involved in a range of practical activities which help them to experience and take account of forces such as tension, compression, torsion, bending, friction and gravity.

experience a wider range of energy sources including magnetic and electrical. They should be given the opportunity to explore and use levers, cranks, cams, gears and pulleys. They should experience the possibilities of the inclined plane, hydraulic, pneumatic, magnetic and electrical devices.

be given the opportunity to use information technology for sporting, processing information and controlling energy such as moving a buggy-vehicle or working a lighting system.

AT3

have opportunities for asking questions, seeking answers, discussing and evaluating their ideas with their teacher and other pupils.

develop an increasing competence to talk and write about their activities, what they found out, observed, investigated or made, representing their ideas through drawings and diagrams where appropriate. They should develop the ability to translate two-dimensional drawings or plans into three-dimensional shapes.

be encouraged increasingly, to select the form of communication most suitable for the material to be communicated and the audience who will receive it.

experience the use of a computer for word processing, and data handling. They should have the opportunity to use a computer to control external devices and monitor aspects of the environment (such as temperature or animal behaviour).

1988 Schools Design Prize
Sixteen year old Alison Borer from Windermere, has made a wet suit to her own design — and won a 1988 Schools Design Prize.

