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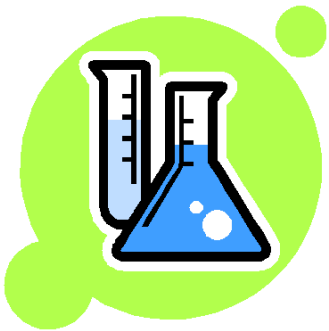
Science



school policy

November 2019

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1- Introduction

1.1 Introductory statement

We believe that children construct, modify and develop a broad range of scientific concepts and ideas through the Science curriculum, involving them in observation, questioning, discussion, prediction, analysis, exploration, investigation, and experimentation, while the knowledge and skills they acquire may be applied in tasks involving designing and making.

Science education plays a key role in promoting children's sensitivity to, and a personal sense of responsibility for, local and wider environments. It aids the development of an appreciation of the world around them and the interdependence of all living things, encouraging responsible attitudes and behaviour towards the environment.

The school has a tradition of promoting Science, having been one of four schools that exhibited in the first primary schools' section in the Young Scientists' Exhibition (1996), and again in 2001 . The school has successfully participated in the Primary Science initiative since its inception in 2004.

1.2 Rationale

This policy was formulated through staff collaboration co-ordinated by the principal, and in consultation with the Board of Management, following in-service training as part of the implementation process of the revised Primary Curriculum (1999).

The purpose of the policy is

- to benefit teaching and learning in our school;
- to provide a coherent approach to the teaching of science across the whole school;
- in order to ensure that pupils are given adequate opportunities to develop skills and understanding of concepts as envisaged in the Primary School Curriculum.

2. Vision and aims

2.1 School characteristic spirit / ethos

The Science programme in our school should help children to work scientifically, involving a wide range of skills of enquiry, the cultivation of important attitudes and the acquisition of scientific knowledge and concepts about the biological and physical aspects of the world.

As noted in the school's Mission Statement,

> pupils are encouraged to reach their full educational potential, by developing intellectual skills combined with a spirit of inquiry and the capacity to analyse issues critically and constructively, while developing expressive, creative and artistic abilities. Children are encouraged to be active in their own learning.

2.2 Aims and objectives

We endorse the aims of the Primary Curriculum for Science

- to develop knowledge and understanding of scientific and technological concepts through the exploration of human, natural and physical aspects of the environment;
- to develop a scientific approach to problem-solving which emphasises understanding and constructive thinking;
- to encourage the child to explore, develop and apply scientific ideas and concepts through designing and making activities;
- to foster the child's natural curiosity, so encouraging independent enquiry and creative action;
- to help the child to appreciate the contribution of science and technology to the social, economic, cultural and other dimensions of society;
- to cultivate an appreciation of, and respect for, the diversity of living and non-living things, their interdependence and interactions;
- to encourage the child to behave responsibly to protect, improve and cherish the environment and to become involved in the identification, discussion, resolution and avoidance of environmental problems and so promote sustainable development;
- to enable the child to communicate ideas, present work and report findings using a variety of media;
- to promote environmental awareness and appreciation through our gardens, as well as other on-campus activities such as tree identification, etc, through the school's Green School programme.

- When due account is taken of intrinsic abilities and varying circumstances, the school recognises the objectives for the Science curriculum as being to enable the child to

- develop an interest in and curiosity about the world through the exploration and study of living and non-living things;

- develop a knowledge and understanding of scientific ideas through the study of living things and the environments in which they live, energy and forces, materials and processes of change;

- observe, ask questions, discern patterns, hypothesise, plan, experiment, design, make, measure, discuss, analyse and evaluate results and so develop a scientific approach to problem-solving;

- develop and apply constructive thinking in scientific investigations;

- understand the application of some basic scientific ideas and concepts in everyday situations;

- apply and use scientific knowledge, skills and resources in designing and making tasks;

- communicate and record observations, evidence and results of experiments and investigations using a variety of oral, written and graphical forms and other media;

- explore the environmental repercussions of human actions on physical, natural and human environments;

- understand the interdependence of a wide variety of living things and their environments, recognise the importance of conserving habitats and environments, and begin to understand that all life now and in the future depends on the sustainable development of the planet ;

- become actively involved in the discussion, exploration and resolution of environmental issues;

- understand and apply a safety code in scientific and technological investigations and activities.

3. Content of Science plan – curriculum

The teaching of science in the primary curriculum involves the development of two types of understanding: conceptual understanding and procedural understanding. The four strands of the science programme (Living things, Materials, Energy and forces, and Environmental awareness and care) outline the knowledge and understanding that children acquire and describe the scientific ideas that they will encounter. The section of the science curriculum entitled 'working scientifically' outlines how children may engage in scientific enquiry. It is a procedural model of how scientists work and includes statements of the various skills that contribute to this methodology.

Content objectives/strand units are selected by each class level in order to ensure appropriate development from class to class. This is arranged by agreement by the teachers of each group of two classes. Work from each strand is included for each year. A broad range of topics from each of the strands in the curriculum is included, and a thematic approach is adopted at certain times.

Teachers ensure that children's learning relates to everyday experiences. The teaching of certain aspects of the science programme in relation to human growth, development and reproduction is in line with the school's plan for the RSE elements of SPHE.

3.1 Children's ideas

The development of children's ideas is central to science education. Young children come to science activities with ideas that they have formed from previous experiences. They use these ideas to make sense of the things that happen around them. These ideas tend to be limited to concrete, observable features and may be inconsistent with the formal theories of conventional science. To change these alternative ideas or misconceptions it is necessary for pupils to become consciously aware of their ideas, and then to have these ideas challenged and debated. Meaningful learning occurs when the pupils construct their understanding by modifying their existing ideas in the light of new insights gained from scientific investigations. Science may then be seen as the active process of the personal building of meaning and understanding.

As well as planning science lessons on the basis of knowledge, skills and understanding, the children's ideas are often used as a starting point for scientific activity (ref *Teacher Guidelines*, p 3). Some of the strategies used to find out the children's ideas include play scenarios, talk and discussion, questioning, listening, problem-solving tasks, annotated drawings, teacher-designed tests or tasks, and concept mapping.

To give children an insight into Science in a real-life context the senior classes endeavour to attend the annual BT Primary Science Fair and BT Young Scientist and Technology Exhibition. Senior classes endeavour to participate in various science initiatives such as the ESB Science blast to show case their investigations alongside other primary schools from around the country. The school also applies to receive the Science Foundation Ireland Plaque of Excellence in STEM on an annual basis.

3.2 Practical investigations

Practical investigations are encouraged in all classes. Investigations allow for differentiation to meet the needs of all the children in the school, in accordance with school policy on inclusion. The children are encouraged to apply scientific concepts to everyday situations, and combinations of closed activities are used, as well as open investigations (ref *Teacher Guidelines* p. 54). As appropriate, teachers arrange opportunities for children to engage in free exploration of materials

3.3 Key methodologies

(ref *Teacher Guidelines* pp 52 – 145).

The key methodologies of the primary curriculum are utilised by

- using the environment
- active learning
- guided and discovery learning
- free exploration of materials

Activities are adapted and modified so that they meet the needs of all children in the class *(*ref *Teacher Guidelines* p 35).

3.4 Balance between knowledge and skills

Throughout the various curriculum strand units, the children have numerous opportunities to work scientifically through

- questioning
- observing
- predicting
- estimating and measuring
- analysing
- recording and communicating

The children work through all the skills involved in designing and creating/constructing by

- identifying
- exploring
- planning
- making
- evaluating

3.5 Integration

(ref *Teacher Guidelines* p34, and exemplars for integrated units of work, *Teacher Guidelines* pp 46 - 49).

SESE

While science makes an important and distinctive contribution to the development of the child, scientific education also complements the growth of the child's learning in geography

and history. All three contribute to the wider social, environmental and scientific education of the child, and their complementary roles will be reflected in the organisation of learning. Throughout the primary school, and in the early years especially, much learning in science, geography and history will take place through the integrated themes or topics that teachers use to organise their work. Many of these topics will arise out of the child's need to explore and understand his/her immediate environment and local community. The curriculum and its accompanying guidelines, suggest how the development of valuable scientific skills, concepts and knowledge will be achieved as these topics are explored.

Environmental awareness and care

The curriculum area of SESE is specifically founded on the pupils' relationship and interaction with the world around them, and the locality provides the starting points for environmental education. Pupils should develop a broad and balanced view of the environment, appreciating the ways in which science and technology can help people to use resources for the social, cultural and economic benefits of humanity.

Science and technology: designing and making

Designing and making encourages the creative and imaginative aspects of the scientific process. Skills of exploring, planning, designing and making enable children to apply their scientific knowledge and understanding to devising a method or solution, carrying it out practically and evaluating the final product. The skills involved will be developed progressively through the school as children tackle open-ended problem-solving tasks. Designing and making is a process that draws on the whole curriculum and is developed in association with and through Visual arts, Science and Mathematics.

Language and science

Language is such a pervasive influence in the teaching and learning process that particular examples of the integration of science with language are not delineated in the curriculum statement. Much of the child's learning in science takes place in the interaction between language and experience. Through discussing their ideas and the results of their scientific investigations children will develop their scientific understandings. Through language children name and classify things, express and modify ideas, formulate questions and hypotheses, and report conclusions. In this way language contributes to the expansion of the child's conceptual development.

Language is the principal means of communication in every aspect of the learning process. The teacher uses language to question, to explain, to suggest, to prompt, and to stimulate the child to think. The children are encouraged to describe, discuss, predict, explain, hypothesise and analyse ideas. Language is important, too, in helping children to access and to retrieve information and to record and communicate ideas. The extent, therefore, to which language is an integral part of the teaching and learning process is a consistent consideration in the planning and implementation of the Science curriculum.

3.8- New language curriculum

As part of the New Language Curriculum teachers will endeavour to teach aspects of science lessons through Irish in order to provide the same learning experiences across both languages. The priority and emphasis will remain on the concept being taught but elements of the lesson can be delivered through Irish.

4. Content of Science plan – organisation

4.1 Classroom management

A teacher-directed approach is used in all classes (ref *Teacher Guidelines* p. 54). Pupils are enabled to work on their own problems as far as possible. Teachers ensure that children have an opportunity to work in different groupings, e.g. whole group, small groups, pairs and individually, and ensure that children have an opportunity to work collaboratively and co-operatively.

All children have easy access to materials that may be needed for all Science activities. The children are given an opportunity to share ideas and communicate their findings through assignments, class discussion, demonstrations and display of work/models and projects (ref *Teacher Guidelines* p. 52).

4.2 Using the environment

(ref the school's *environmental audit;* and *Teacher Guidelines for Geography* pp 74 - 80)

A number of features of the local environment are incorporated into the Science programme. This includes a range of habitats and features of the natural and built environment within easy reach of the school, eg seashore habitat, rock pools, hedgerows, school grounds.

The school has a large campus, and there are numerous habitats and amenities in the school's immediate environment. The immediate environment has been enhanced through the provision of logs for insects, the development of a butterfly garden etc. Pupils are given opportunities to observe a variety of living things in their immediate environment. There is a *Nature trail* around the school grounds, of which each teacher has a copy (the master copy is in the Staff Resource Library). There is also an *Environmental trail* that looks at the local built environment in Greystones, and a *Tree map* of the school grounds identifying each variety.

A number of people/groups within the locality continually act as a resource to the school's Science programme, and are willing to visit the school on occasions such as Science Week.

The school organises and participates in schemes to foster environmental awareness and care. These include the Green Schools project, recycling projects, composting, energy efficiency policies, etc. (ref *Green Schools* programme). These are among the many aspects of school life with which parents or members of the wider community involved. The school models good environmental practices, e.g. collecting samples for nature displays, packaging/waste paper, etc. Appropriate use is made of recyclable materials for science and other activities.

4.3 Assessment and record keeping

(ref school's policy on Assessment and record keeping, *Teacher Guidelines* pp 142-145; *Curriculum* pp 98-107)

The children have opportunities to record their work in a variety of different ways, eg concrete materials, oral presentation, drawings, photographs, written records, video, concept maps, etc.

Assessment is an integral part of teaching and learning in science, as in other areas of the curriculum. A range of informal and more formal assessment techniques assist in enriching the learning experience of the child and provide useful information for pupils, teachers, parents and others. Teachers use a range of assessment tools (ref Appendix 1)

- Teacher assessment
- Teacher- designed tests and tasks
- Concept mapping
- Work samples.

Some of this is on-going, while some is at set times eg at start/end of a unit of work, or at the end of a term/year. Information from class assessment informs planning and teaching.

The child's knowledge is assessed along with skills development. The children are encouraged to predict outcomes of experiments and record their results. This involves a certain level of self-assessment.

Teachers share information with each other at the start-of-year meetings, and on an on-going basis as needs arise. Information is shared with parents at start-of-year class-based meetings, at mid-year parent/teacher consultations, and through end-of-year reports, as well as being available to meet parents throughout the year, on request.

4.4 Children with different needs

Through lesson planning for differentiation, consideration is made for special needs within the group, and plans are made and modified as required to cater for the range of learning abilities in our science teaching, eg, children with general and specific learning disabilities, children receiving learning-support, children whose first language is not English, or children who are exceptionally able.

Special Needs Assistants (SNAs) assist the class teacher during Science activities, eg by helping with supervision of group work during experiments, field work, etc.

The school provides challenges for children of exceptional ability using some of the following measures/opportunities as appropriate:

- differentiated programme within the classroom and/or homework;
- ICT;
- independent research projects;
- working with parents/older pupils;
- consulting organisations such as An Óige Thréitheach, Irish Centre for Talented Youth in DCU;
- other measures/opportunities as they arise.

4.5 Equality of participation and access

(ref school's *Equality of access and participation policy*)

As with other SESE subjects, opportunities within the science programme are used to broaden the pupils' understanding of other cultures and environments eg by noting fabrics used in warmer climates, colours of clothing, materials used for building homes, etc.

The issues of human growth, development and reproduction are catered for primarily within the SPHE programme. However, teachers are always available to discuss parental concerns regarding this area, should it arise within science lessons.

All children will have access to services, facilities, or amenities in the school environment (ref school's *Equality of access and participation policy*).

All lessons will be differentiated to ensure children of all abilities and children will additional educational needs will be catered to.

4.6 Timetable

Science is timetabled separately within all class timetables, though there may be opportunities for an integrated approach, especially with other SESE subjects, from time to time.

A central timetable is coordinated by the Principal to organise the sharing of resources such as the ICT room and GP hall. A copy with this plan is given to all teachers, and displayed in the staff room.

The school organises a range of specialist 'theme weeks' annually. This may include a 'Science week' where the children are involved in a wide range of scientific activities, exhibitions and practical demonstrations hosted by different classes throughout the school.

When drafting timetables for withdrawal of pupils for Learning Support and Resource teaching, consideration is made that these pupils be able to participate in as much of the science programme as possible.

4.7 Homework

(ref school's *Homework policy*)

Science assignments are given for homework, when considered appropriate by the class teacher, ie activities that are particularly suited, such as observation, investigation and recording that can be done at home.

4.8 Resources and equipment

- Curriculum documents for Science, Geography and History
- *Primary School Curriculum, Your child's learning, guidelines for parents*
- NCCA *Draft Guidelines for Teachers of Students with General Learning*

- *Disabilities*, 2002
- *Looking at our school* (2003) DES

Websites

DPSM	www.sfi.ie
Heritage in Schools	www.heritage council.ie
PPDS	www.ppds.ie
NCTE	www.ncte.ie/internetsafety
DES	www.education.ie
NCCA	www.ncca.ie
INTO	www.into.ie
IPPN	www.ippn.ie
NPC Primary	www.npc.ie

Pupils use textbooks, workbooks, worksheets / science supplements (ref *Teacher Guidelines* p27)

The Science Curriculum is generally well resourced, (ref *Inventory of Science equipment & resources* and *ICT inventory*, also *School library*). Most Science resources are centrally stored in a designated store in the ICT room, where they may only be accessed by staff.

A copy of the science inventory is available from the Science co-ordinator and there is a copy with the equipment store (in the ICT room. Each teacher is responsible for returning equipment borrowed and informing the coordinator if something needs replacing, repair or replenishing.

4.9 ICT

(ref school's *ICT policy*, *Teacher Guidelines* pp 140 – 141, and *Information and Communications Technology (ICT) in the Primary School Curriculum: Guidelines for Teachers*).

ICT is an important resource and tool for learning in Science in the school. Children's investigations and explorations are enhanced by using ICT in recording and analysing information, in simulating investigations and tests that support scientific topics, in science investigations and in accessing a range of sources of scientific and technological information.

The school has an *ICT Acceptable User Policy* (AUP) to ensure safe internet usage. Appropriate hardware and software have been installed to ensure this safety, and teachers familiarise themselves with material on websites prior to use by the children. Websites are also centrally monitored by NCTE.

4.10 Health and safety

The school's *Safety statement* deals adequately with science activities, while the *Tours and excursions policy* addresses working outside of the classroom/school.

Teachers outline the need for safe procedures and routines with the children and the general safety routines for Science activities are followed (ref *Teacher Guidelines* p 27)

- Outdoor exploration and investigation - ref *Teacher Guidelines*, pp 58 – 59
- Light - ref *Teacher Guidelines*, p 86
- Electricity – ref *Teacher Guidelines*, p 97
- Magnetism - ref *Teacher Guidelines*, p 105
- Forces – ref *Teacher Guidelines*, p 107
- Heat - ref *Teacher Guidelines*, p 129

4.11 Individual teachers' planning and reporting

All teachers have a copy of the school policy/plan for Science. Alongside the Curriculum documents, this is used for reference when preparing long-term and short-term plans, providing information and guidance to individual teachers.

Teachers' monthly reports are very helpful when reviewing and/or developing all curricular areas, including Science.

4.12 Staff development

A member of the ISM team has particular responsibility for overseeing the area of Science. She is assisted by one, or more, staff who volunteer on an annual basis to help with this curricular area. The member of the ISM team has a particular interest and expertise in Science and is always proactive in encouraging colleagues in this area and willingly shares her expertise with colleagues. This post is currently held by Sorcha Ryan.

The coordinator facilitates support for any individual teacher who needs help in developing the required knowledge and skills to facilitate pupil learning in some aspects of the science curriculum. This may include peer coaching and/or team teaching in these areas.

Teachers are encouraged to attend courses relating to the teaching of Science, and to share the expertise acquired at these courses through our staff meetings and in-school SDP.

4.13 Parental involvement

(ref *Science Curriculum* and *Guidelines for Parents - your child's learning*) Parents are aware of the nature and purpose of the science curriculum. The school arranges for information to be given to parents individually (if requested, and through end-of-year reports), in class groups (annually), in whole-school meetings (occasionally).

Parental support in the implementation of the Science plan is greatly appreciated. This includes support with individual activities (e.g. lessons, trips, displays, homework), and opportunities such as the Science Week.

Parents will be invited to view their children's work in all curricular areas, as part of our home/school communication policy. They have a special opportunity to support their child's Science programme by participating and attending Science Week.

Science related school events projects and achievements will be shared through our monthly online newsletter.

4.14 Community links

Members of the community are involved in supporting the Science programme, through occasional visits. The school has participated in the *Young Scientists' Exhibition*, and the *Discover Primary Science* initiative.

We will engage with local experts through-out the year visiting local discovery centres or arranging visits from local experts through initiatives such as the Heritage in Schools where facilitators can present through English or Irish.

5 Success criteria

We will know that the plan has been implemented successfully if

- teachers' preparations are based on the plan
- the procedures outlined in this plan are consistently followed.

We will know that the plan has achieved its aims by

- Inspector's suggestions and/or reports
- feedback from second level schools
- observing a scientific approach to problem solving amongst the children.

6.1 Roles and responsibilities

The plan is supported, developed and implemented by the staff, Board of Management and parents.

6.2 Timeframe

On completion of the most recent review to take account of the change in school resources and facilities in 2019, the policy was implemented immediately following its ratification by the Board of Management.

7. Review

7.1 Roles and responsibilities

Under the leadership if the designated ISM team member, those involved in the review will include representatives of ISM, teachers, BOM, parents, and pupils (where appropriate). Pupils' work will assist in informing the review process, and feedback from parents will assist in informing the review.

The Science coordinator is responsible for checking that tasks have been completed in accordance with the agreed timeframe.

7.2 Timeframe for review

It is necessary to review this plan on a regular basis to ensure optimum implementation of the Science curriculum in the school. However, this policy will be fully reviewed in 2021.

8. Ratification and communication

This policy was ratified by the Board of Management in December 2019. It was immediately made available to all teaching staff on the school ICT server and was made available to parents through the school office.

Appendix 1

Assessment in Social, environmental and scientific education

Assessment: an integral part of teaching and learning

The assessment of children's learning is an essential and on-going part of the teaching and learning process in SESE: in some form it will be part of every lesson in science, geography and history. Teachers are constantly making judgements about their pupils' learning as they plan how to introduce new areas of knowledge, concepts and skills, consolidate earlier lessons, assess the progress of individual pupils, identify difficulties, and praise and encourage learners.

Assessment enhances the teacher's awareness of each individual's learning, provides accurate information about the child's understanding and skills, and creates a picture of the child's holistic development throughout the broad range of curricular areas. It provides the basis for decisions about the pupil's further learning needs, assists in planning better educational experiences and is a natural element of a progressive child-centred curriculum.

Roles of assessment: Why assess in SESE?

Assessment enhances teaching and learning in a number of ways. Primarily, assessment in SESE, as in other areas of the curriculum, should assist in planning and supporting future learning for the child. Assessment should indicate the positive achievements of each pupil as he/she is engaged in the study of scientific, historical and geographical topics and should indicate possible areas of development in the child's learning. Used in this way, assessment plays a constructive, formative role in the child's education. Information gained about the child's learning will be used primarily by the teacher but it will also involve the pupil in self-evaluation and in the setting of personal learning targets.

Assessment will also indicate areas of learning difficulty encountered by the child. The learning difficulties identified in SESE may include weaknesses in the child's understanding, gaps in his/her knowledge or a lack of certain skills. As assessment fulfils this diagnostic role, it should help the teacher to identify approaches or learning experiences that could help to improve the child's learning. At times learning difficulties may be identified in one aspect of the child's scientific, historical or geographical development, but on other occasions a weakness encountered in one area of SESE will reveal information about the child's learning in the other SESE curricula. Many teaching and learning experiences in science, geography and history draw on and use a wide range of skills and concepts, so SESE may also provide valuable opportunities to gain evidence of a child’s progress in areas such as mathematics, language and social development.

Assessment should provide an indication of the child's overall achievement in a systematic way at regular intervals. Assessment may be used to fulfil this summative role when teachers seek to establish the outcomes of learning following completion of a unit of work or when they report to audiences beyond the child, for example when they communicate with parents or other teachers about the child's progress.

Assessment can also help the teacher to evaluate the suitability of the SESE programme selected by the teacher and school for a particular age group and can assist the teacher in assessing the effectiveness of the educational resources, methodologies and approaches deployed. Used in this evaluative role, assessment can help to identify how the learning experience could be improved for the child.

Assessment in science

To fulfil these various functions successfully, assessment must be valid and must seek to measure and report on the child's progress and achievements throughout all aspects of the science curriculum. The assessment techniques in science must focus on knowledge objectives, understanding of scientific concepts, competence in the application of experimental and investigative skills and the cultivation of important attitudes.

Strands and strand units

The strands and strand units of the science curriculum outline the knowledge areas of the curriculum and suggest ways in which scientific skills may be developed as these units of work are completed. The objectives and italicised exemplars indicate the range of knowledge that may be expected at each level, and the section 'Planning a unit of work' in the accompanying teacher guidelines illustrates how these may be used to form the basis of teaching and learning activities. The knowledge objectives outlined in these units should form one aspect of assessment.

Schools and teachers have considerable flexibility in the selection of appropriate topics for the science programme. Side by side with this flexibility is the requirement of achieving a balance between the four strands, i.e. Living things, Materials, Energy and forces and Environmental awareness and care. The strand Environmental awareness and care is a major cross-curricular link and has been designed so that it will be delivered through the science and the geography curricula. Many strand units of the geography and science curricula integrate with each other and a coordinated approach in the teaching of both these areas within SESE will be required. The flexibility offered by the curriculum and the requirement that children study units from different strands makes comprehensive planning, effective summative assessment and record keeping essential within the school.

Working scientifically

Science is about understanding certain aspects of the physical world around us, and it involves testing and changing ideas about how natural and manufactured things work. Practical investigation is central to scientific activity of all kinds. Children begin from their ideas and change and develop these ideas by testing them in practical investigations. The development of knowledge, concepts and skills is interdependent, and the assessment of both these aspects of the scientific process is of equal importance. At each class level of the curriculum the sections 'Working scientifically' and 'Designing and making' outline the specific skills that will enable children to develop ideas and make sense of the world around them. The objectives listed in these sections indicate the degree of skill that should be expected of children working at each level.

The skills outlined in 'Working scientifically', which include questioning, observing, predicting, investigating and experimenting, estimating, measuring and analysing, mirror those included in the geography curriculum under the heading 'Geographical investigation skills'. Their inclusion in the geography curriculum indicates that an investigative approach should inform children's explorations of the environment and that significant aims of the science curriculum can be achieved through geographical topics. Opportunities for the application of science investigation skills arise both in geography and science, and assessment techniques will therefore have to take cognisance of the wide range of units within which skills can be assessed.

The assessment of skills is a complex activity. Process skills of science are concerned with activity and application and are therefore less readily assessed by techniques that rely on a

written or other product. The performance of some process skills has to be observed in action so that the teacher can be confident that they have been used and can judge the level of operation. The ability with which a primary child applies process skills is demonstrated best in practical investigations, where the concepts being developed are discussed and tested and approaches to solving problems in real contexts are explored. Thus if assessment is to be a valid indicator of the children's scientific understanding it must seek to record and acknowledge the ability that pupils demonstrate in a variety of practical learning situations.

Values, attitudes and responsibilities

Assessment in science will also be concerned with values and attitudes that are developed in the child as he/she is engaged in the study of scientific topics. Through science education children will develop attitudes of curiosity to try new experiences, to find out how things work, to explore and to discover more about the things around them. Through their scientific investigations children develop informed critical and scientific perspectives, which acknowledge the importance of founding judgements on a respect for evidence. This involves the child in developing attitudes of open-mindedness to the ideas of others and a willingness to consider conflicting evidence and ideas. Helping children to understand that scientific ideas are tentative should encourage the development of attitudes of flexibility and the ability to modify their ideas in the light of new evidence.

This growth in skills of enquiry and concepts should be accompanied by a development of sensitivity towards living things and the cultivation of a personal sense of responsibility towards local and wider environments. Science investigations based on the strands Living things and Environmental awareness and care will encourage children to become active agents in the conservation of environments and to adopt responsible attitudes and behaviour that will promote more sustainable use of the Earth's resources. The development of these attitudes is fostered by a balanced curriculum of scientific topics based in local and wider environments. The provision of opportunities for children to work scientifically in the outdoor environment will make a significant contribution to the cultivation of positive attitudes. Assessment of the child's attitudes in science will rely strongly on the teacher's observations and his/her professional judgement of the child's approach to scientific investigations. Field trips, working in the school garden, tending the bird table and nature walks and trails are examples of opportunities for the teacher to observe the child's patterns of behaviour towards the environment.

Assessment tools: how to assess

Assessment in science is concerned with the children's mastery of knowledge and understanding of the strands of the science programme and the development of skills and attitudes. Consequently a broad range of assessment tools and approaches will be necessary. The assessment techniques employed will arise naturally out of teaching and learning, and their effectiveness will be dependent on teacher skills of observation, listening, interacting with pupils and scrutinising the outcomes of learning tasks used in science. Reliable judgements of pupils' performance need to consider the capacity of children to achieve in a variety of contexts. Thus assessment will be a continuous process and will be part of the normal teaching and learning situations.

The following are among the assessment tools that schools will find most useful in science:

- teacher observation
- teacher-designed tasks and tests
- concept-mapping

- work samples, portfolios and projects
- curriculum profiles.

It should be understood that it may be neither practicable nor desirable to use all these tools in every learning situation or within a particular time span.

Teacher observation

Observations made by the teacher during practical science tasks provide opportunities to assess the development of process skills and attitudes and to establish the extent to which children have mastered the knowledge aspects of the science programme. Teachers should consider criteria outlined in the school plan, the skills and knowledge objectives of the science curriculum and the levels of maturation of the pupils when forming judgements based on their observations of children's practical tasks. These knowledge and skill objectives might form the basis for guidelines for describing children's progress at different class levels. Checklists of specific items related to particular tasks might be devised. For example, for children in first and second classes such a checklist might include such questions as:

- Had the child a clear idea about the purpose of the investigation?
- Did the child ask questions that related to the problem?
- Did the child make observations using more than one sense?

Informal observation of practical tasks in science will involve the teacher in taking an active role in the learning situation. Through open-ended questions the teacher can gain an insight into the children's conceptual understanding, attitudes to scientific investigations and use of process skills. During these observation periods the teacher may make written notes so that further work for an individual or group can be planned and a record kept for future reference.

Other observations of children's learning and activity may be planned and structured. In these observations the teacher will generally concentrate on seeking evidence of one or two process skills, for example on the extent to which pupils plan experiments during one lesson and ask questions during the next. The teacher will watch the children as they work and listen to their interactions so as to obtain evidence of skills or scientific ideas.

Observation in the science lesson will focus on:

- individual discussion;
- how a child carries out an investigation as part of a group;
- the group, and the interaction of individuals within the group;
- the responses the child makes to the teacher's questions and suggestions;
- the participation of the child at different stages of investigation, for example planning, identifying variables and evaluating;
- the way the child reacts to tasks and to the identification and solution of problems in a variety of environments.

The assessment of practical tasks in science takes a wide variety of forms. Written records, drawings and reports of investigations provide children with a record of their own work. However, they rarely supply the teacher with the information required about the level of skill used and the way in which children work. Teacher observation, discussion and questioning of children during practical tasks allow assessment of the performance of skills.

Practical tasks may focus on

- a specific practical skill or process skill, for example the ability to use measuring instruments in a scientific investigation or the ability to make observations;
- a number of skills being used at the same time;
- open-ended investigations, for example the ability of the child to identify and control variables;
- model-making in problem-solving contexts;
- explorations and investigations in the outdoor environment.

Teacher-designed tasks and tests

Throughout the units of the science curriculum teachers will identify opportunities for children to engage in a range of tasks. These will have a number of purposes. Some will be designed to engage the child in asking questions and thinking about scientific concepts and knowledge, while others will promote a range of scientific and technological skills. Some representational record, whether written, drawn, sculpted or modelled, that can be used to convey the children's ideas, questions and discoveries is necessary to build up a precise picture of the child's achievements in a variety of contexts. Children's reactions to these tasks will indicate their progress in science.

A wide variety of tasks should be provided for children, including:

- observing both inside and outside the classroom recognising patterns in observations and evidence;
- analysing objects and processes and hypothesising about how models and systems work or are made;
- predicting outcomes of an investigation;
- collecting information from sources such as direct observation in the environment and in the classroom using books and other materials;
- asking questions;
- providing oral, written and pictorial accounts of investigations or stages of investigations and experiments;
- completing and displaying projects and reports of topic work;
- using work cards or activity sheets that guide children to apply process skills;
- designing, making and evaluating models and structures that provide solutions to problems;

- evaluating the evidence generated by an investigation;
- using interactive multimedia computer programs that enable the child to explore scientific themes and topics and complete a range of tasks and problems;
- exploring and engaging in practical investigations in the environment;
- completing teacher-designed revision tests on a unit or units of work;
- evaluating the outcomes of design-and-make activities displaying and reporting project work in progress or when completed;
- estimating, measuring or comparing;
- making drawings of the evidence of visual observations, plans for investigations or methods to be used in investigations. The value of expressing ideas through drawing with labels is greatly increased if the teacher discusses the drawing with the child and annotates it as a result of asking questions.

Concept-mapping

One of the primary principles on which the science curriculum is based is the recognition that children come to school with preconceived ideas about the biological and physical world. The child's initial ideas must be explored and taken seriously if they are to form the starting point for learning. Concept-mapping helps children to record and discuss their ideas as the starting point for learning. Concept maps are schematic representations of relationships between concepts. A list of concept words that are known and that can be linked together is drawn up in discussion with the children, who are then asked to draw lines and write joining words between the different words. The results can be analysed to give an insight into the relationships that children see between things. They provide the teacher with information about the ideas children commonly hold and about how they can explore and respond to the ideas of their own pupils.

Work samples, portfolios and projects

The compilation of a range of samples of a child's work to form a science portfolio provides a systematic means whereby progress can be documented and assessed over a term, a year or a longer period. Products arising at all stages of an investigation will indicate the children's ideas. The shape used for a boat, the way a tower is constructed to support something, or how Plasticine is moulded to make it float provide teachers with an understanding of how children are thinking and of the ideas they are developing. The portfolios should contain samples of work in progress or what the individual child considers to be 'best samples' of finished pieces together with the teacher's comments. The samples included in the portfolios should demonstrate the children's achievement in a range of areas. Several samples of work in one area may be included to show the progression and development of children's ideas and process skills.

Written accounts or drawings, photographs of stages of an investigation, graphs, samples of worksheets or audio tapes of children's reports of investigations might also be enclosed.

Reviewing the contents of the portfolio with the pupil can encourage the child in

self-assessment and the setting of new learning targets. It also provides an excellent basis for the reporting of pupils' achievements to teachers, parents and others, and can allow weaknesses to be identified. In addition, the systematic analysis of science portfolios can allow the teacher to evaluate the content, methodologies and approaches he/she has used over a term or year.

Curriculum profiles

Teachers may find curriculum profiles useful for the systematic observation and recording of children's progress and achievements while work is being done in science. The profile consists of descriptions of the range of knowledge, skills and attitudes that might be expected of children at different stages of development. These descriptions, sometimes written in the form of short paragraphs, are indicators of behaviours or abilities that children may demonstrate. Teachers seek to match their observations of pupils to the indicators in the profiles as work on units is in progress or is completed and at other regular intervals. Where aspects of paragraphs are marked or highlighted in line with pupil achievement, profiles can also serve recording and reporting functions.

The indicators relating to scientific skills should be based on the sections 'Working scientifically' and 'Designing and making', while the other indicators should be based on the knowledge content of those strand units that are included in a school's science programme and on the attitudes that are described in the aims and broad objectives of this curriculum statement. The emphasis placed on the local environment and the close links which the strand units and skills sections of the science curriculum have with the geography curriculum should also be borne in mind.

The discussion of curriculum profiles by teachers from clusters of schools would enhance their reliability as assessment tools. Such discussion would have the added advantage of contributing to increased expertise in the organisation of activities in science for pupils.

A balanced approach to assessment in SESE

The primary aim of all assessment is to enhance the learning experiences of the child, and it will be important that the assessment techniques employed in science and in other areas of SESE should not detract from teaching time. The school's policy for science should guide teachers in using assessment tools in a manageable and reliable way that is closely integrated with teaching and learning. The development and use of common approaches to recording teacher observations, the outcomes of learning experiences and the compilation of portfolios and curriculum profiles will facilitate a balanced and practical approach to assessment in the school.

Recording and communicating

Teacher observations, teacher-designed tasks and tests and work samples and portfolios, together with curriculum profiles and pupil profile cards, constitute a comprehensive system of assessing and recording each child's progress and achievements in the science programme. The pooling and discussion of this information among the teaching staff can enable teachers to share expertise and develop a common understanding of pupil progress and assessment in SESE (in a process referred to as moderation). Such co-operation can help to ensure continuity and reliability in the use of the assessment tools.

The range of assessment tools in SESE should provide essential information about the child's learning for pupils, teachers, schools, parents and other professionals and so facilitate future decisions about the child's learning. Teacher-parent discussions will provide opportunities for parental feedback and will enhance the overall assessment of the child.

Pupil profile card

The recording and communication of this information about the child's progress will be facilitated by the use of a pupil profile card. The pupil's profile card, which may be developed for use in all primary schools, should contain a summative assessment of the child's progress in all curricular areas and of other aspects of his/her development. The teacher's professional judgement of the child's development in science, based on the outcomes of teaching, learning and assessment throughout the year, will form one aspect of the profile card. The section of the profile card for SESE should be sufficiently flexible to allow for the highly integrated nature of the area in infant, first and second classes. As the profile card should provide a basis for the planning of the child's future in another class or school, it should include, or be accompanied by, information regarding the selection of science topics that the child has explored.

The possibilities and advantages offered by information technology in facilitating the recording, storage and transfer of pupil profile records should be explored and if possible, used in the compilation of any widely used pupil profiling system.