Science in the Primary School 2008

Inspectorate Evaluation Studies

PROMOTING THE QUALITY OF LEARNING

AN ROINN OIDEACHAIS AGUS SCILEANNA | DEPARTMENT OF EDUCATION AND SKILLS

INSPECTORATE

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Foreword

The inclusion of Science in the *Primary School Curriculum (1999)* brought a major change to the curriculum of primary schools and reflected the importance that science and technology have in many aspects of our daily lives, at work, at school and at home. Our dependence on science and technology requires that all pupils develop a high level of scientific literacy. The primary Science curriculum offers schools a comprehensive programme from infants to sixth class. It provides a very good foundation for the study of science subjects in the post-primary setting. Most importantly, it cultivates a positive attitude to science and provides pupils with opportunities to experience the excitement of working as a scientist.

Science in the Primary School reports on the implementation of the 1999 science curriculum as this was in evidence during inspections carried out in forty primary schools during 2007. The evidence indicates that a significant number of primary schools were experiencing success in many aspects of the science curriculum and that teachers and pupils were benefiting from the broad and balanced range of learning experiences outlined in the curriculum. Inspectors found evidence that national in-service supports were beneficial and that many teachers had engaged in further professional development in the area of science. They also reported that schools had made good use of the funding available for the purchase of science materials and equipment.

The report also outlines areas for improvement. In particular, inspectors found that schools needed to provide more regular opportunities for pupils to engage in problem solving and open-ended investigations and to develop the skills listed in the *Working scientifically* and *Designing and making* sections of the curriculum. Inspectors were also of the view that schools needed to engage in whole-school planning for the purpose of improving teaching and learning rather than for the purpose of satisfying the requirements of educational legislation. The report also contains recommendations regarding the incorporation of assessment into the teaching and learning process and regarding the integration into schools' science programmes of the many science-related initiatives that have been introduced into schools in recent years

The Inspectorate has a specific contribution to make in evaluating the quality of provision in schools, in advising schools and teachers and in providing policy advice and direction for the system in general. This report makes a significant contribution in each of these areas and presents findings and recommendations that will be of interest to teachers, parents, support services, teacher educators and policy makers.

Chapter 1
Introduction

1.1 Evaluation of curriculum implementation in Science

The introduction of a broad science programme for all classes was one of the key changes in the revised *Primary School Curriculum* of 1999 (Department of Education and Science, 1999a). This report presents the findings of an evaluation carried out in forty primary schools during 2007 that focused on how effectively the science curriculum was being implemented in classrooms and in schools.

1.2 Science in the *Primary School Curriculum*

Science was included in the *Primary School Curriculum* in 1999 as one of three subjects in the area of Social, Environmental and Scientific Education (SESE). Although some focus on Elementary Science had been included in the 1971 curriculum for senior pupils, the 1999 curriculum is significantly more comprehensive than the previous one in a number of respects.

The curriculum requires teachers to implement the science programme from junior infants to sixth class. It sets out a minimum weekly time allocation for each subject. Science is allocated forty-five minutes per week in infant classes and one hour per week in all other classes. This contrasts with the 1971 curriculum, in which Elementary Science was included as a subject in fifth and sixth classes only. In practice, this element of the 1971 programme was not widely implemented.

The science curriculum is structured so that pupils can learn about the biological and physical aspects of the world in four content strands: *Living things*, *Energy and forces*, *Materials,* and *Environmental awareness and care*. The 1971 curriculum, in contrast, offered a limited range of topics for senior classes only.

A key element of the 1971 Environmental Studies programme was ‘nature study’, which focused on animal and plant life in all classes. This programme was absorbed into the science curriculum under the strands, *Living things* and *Environmental awareness and care.* However, the curriculum now requires pupils to adopt a scientific approach to the study of living things.

While the 1971 curriculum emphasised the importance of learning through activity and discovery, this emphasis is more central to the 1999 curriculum. The curriculum now aims to develop scientific skills as well as understanding. Practical investigation is central to scientific activity and the curriculum emphasises the importance of providing pupils with opportunities to test and develop their ideas.

The science curriculum includes two further new emphases. Pupils in every class are introduced to technology through a specific technology section entitled *Designing and making*. Additional emphasis is also placed on the interrelationship between science, technology and the environment. As a result, the curriculum incorporates the strand unit *Science and the environment* which aims to develop the pupils' understanding and appreciation of the ways in which science and technology can help us to use the Earth's resources for the social, cultural and economic benefits of humanity.

1.3 Structure of the science curriculum

The science curriculum aims to develop two types of understanding among pupils: conceptual understanding and procedural understanding.

Conceptual understanding refers to the pupils' knowledge of the biological and physical aspects of the world. Procedural understanding refers to the pupils' understanding of scientific procedures. These two forms of understanding are not developed independently. In particular, a secure understanding of scientific procedures is necessary for the on-going development of conceptual understanding.

Conceptual understanding

Pupils' conceptual understanding is developed through the study of four areas or strands: *Living things*; *Materials*; *Energy and forces*; and *Environmental awareness and care*. Each strand includes several topics called strand units. These are shown in Table 1.1.

Teachers are required to complete work from each strand every year and work from each strand unit over every two-year period. The curriculum is often described as having a spiral structure. This refers to the fact that, as pupils progress from class to class, they revisit each topic, developing and refining their understanding. In the strand unit *Forces,* for example, pupils in the infant classes are enabled to predict whether an object will float or sink on the basis of the material from which it is made. In first and second class, these pupils learn that the shape of the object is also a factor in floating and sinking. In third and fourth classes, they discover that objects float differently in fresh and salt water. In fifth and sixth classes the pupils begin to understand floating and sinking in terms of gravity and the opposing force exerted by water.

Table 1.1: The content strands and strand units of the science curriculum

	Infants	First and Second	Third and Fourth	Fifth and Sixth
Living things	Myself Plants and animals	Myself Plants and animals	Human life Plants and animals	Human life Plants and animals
Energy and forces	Light Sound Heat Magnetism and electricity Forces	Light Sound Heat Magnetism and electricity Forces	Light Sound Heat Magnetism and electricity Forces	Light Sound Heat Magnetism and electricity Forces
Materials	Properties and characteristics of materials Materials and change	Properties and characteristics of materials Materials and change	Properties and characteristics of materials Materials and change	Properties and characteristics of materials Materials and change
Environmental awareness and care	Caring for myself and my locality	Caring for myself and my locality	Environmental awareness Science and the environment Caring for the Environment	Environmental awareness Science and the Environment Caring for the environment

Procedural understanding

Pupils' procedural understanding is developed through two skills sections: *Working scientifically* and *Designing and making*.

The curriculum emphasises that

> what distinguishes a scientific activity from other forms of enquiry is not the sophistication of the ideas used but the process through which these ideas are developed. (Department of Education and Science, 1999b, p.2)

The section of the curriculum entitled *Working scientifically* presents a procedural model of how scientists work and outlines the various skills and knowledge that are required. The skills to be developed by this section of the curriculum are

- Questioning
- Observing
- Predicting
- Investigating and experimenting
- Estimating and measuring

- Analysing
    - Sorting and classifying
    - Recognising patterns
    - Interpreting
- Recording and communicating results.

The development of the pupils' understanding of what constitutes 'a fair test' is particularly important. Pupils learn that in order for a test to be fair, there are always certain things that must be kept the same. For example, when testing various brands of kitchen paper to find out which is most absorbent, pupils learn that the size of the sheet of paper and the volume of water used are among the variables that must be controlled if the results are to be accurate. The curriculum envisages that pupils in middle and senior classes will be enabled to design and conduct their own investigations, controlling relevant variables. This involves pupils in formulating the question to be answered by the investigation and making key decisions about the investigative procedure to be followed. The skills of *Working scientifically* are included also in the Geography curriculum under the heading *Geographical investigation skills*.

Designing and making is the technology component of the curriculum. *Designing and making* aims to provide children with an understanding of the technological process and the ability to apply their scientific skills and knowledge in solving practical problems. Exploring, planning, making and evaluating are the four key elements in *Designing and making*. It is important that pupils are enabled to work independently in this process, particularly in the middle and senior classes. *Designing and making* "should provide the children with the scope to generate their own designs and the freedom to devise their own solutions to problems" (Department of Education and Science, 1999b, p.134).

1.4 Principles of learning in the science curriculum

The science curriculum and the accompanying *Teacher Guidelines* highlight certain key principles that form the basis for effective learning and teaching in Science. These principles provided a significant focus for this evaluation.

a) Children's ideas as the starting point

The constructivist philosophy underpins the science curriculum and it emphasises that the child's existing knowledge and experience form the base for subsequent learning. All science activities should begin with the teacher eliciting the pupils' existing ideas on the topic.

> Meaningful learning occurs when the pupils construct their understanding by modifying their existing ideas in the light of new insights gained from scientific investigations. Thus, Science may be seen as the active process of the personal construction of meaning and understanding. (Department of Education and Science, 1999a, p.7)

The teacher's main role, therefore, is to identify the pupils' existing ideas on a particular topic and to enable them to test and develop these ideas in a scientific manner. The assessment of changes in pupils' concepts and skills is an on-going feature of the constructivist approach.

b) Practical investigations

The importance of activity and discovery methods has been accepted as a key principle in Irish primary education since 1971. In the context of Science, it means that pupils should be given opportunities to test and develop their ideas about the physical world through hands-on, practical problem-solving activities and open-ended investigations.

c) The local environment

The child's immediate environment provides the main context for learning across all four strands of the curriculum. The local environment is a particularly valuable resource for learning in *Living things*. Local habitats are the most appropriate place to start learning about plants and animals. Schools are encouraged to use the habitats that are available locally and to create new habitats in the school grounds. The environment should also be developed and used as a resource for learning in the other three content strands and the skills sections of the curriculum.

d) Balance between knowledge and skills

The emphasis placed on the development of the pupils' understanding of science concepts should be balanced by an equal emphasis on the development of procedural understanding and skills. The *Working scientifically* and *Designing and making* sections of the curriculum provide the basis for much of this work. This balance between knowledge and skills is a feature of all subjects in the *Primary School Curriculum*.

e) Integration and linkage

Young children don't see their world as divided into curricular subjects. At school, learning can be more effective when topics or ideas are dealt with simultaneously in more than one subject. Teachers are expected to plan units of work that make links between different areas and subjects, especially between the SESE subjects: Science, History and Geography.

1.5 The context in which Science is taught

The introduction of Science as a subject in the *Primary School Curriculum* in 1999 posed a considerable challenge for the school system. These challenges related to teachers' own knowledge of Science, the need for learning in the subject to be activity based and the provision of the necessary resources and professional-development opportunities that would address knowledge of the subject matter and pedagogical approaches to teaching Science.

1.5.1 Primary teachers' confidence and competence regarding Science

Traditionally, the interests and strengths of Irish primary teachers were considered to be in the areas of language and the arts, rather than Science. Some of the providers of initial teacher education (ITE) have had science courses in place for many years. Since 1999, all providers have included science education to some extent in their ITE programmes. However, a considerable number of the teachers working in Irish primary schools at the time of the evaluation had not received any pre-service training in science education.

To date, student teachers also have had limited opportunities to pursue Science as a special area of study during their initial teacher education. In 2002, The *Report of the Task Force on the Physical Sciences* (Department of Education and Science, 2002a) recommended that a review of how initial teacher education prepares primary and post-primary teachers to teach Science should be undertaken. The report observed that only a minority of primary teachers had taken a physical science subject in the senior cycle at second-level, and recommended that priority be given to the physical sciences in continuous professional development for primary teachers.

The publication by the Teaching Council in June 2011 of *Initial Teacher Education: Criteria and Guidelines for Programme Providers* set out, for the first time, common learning outcomes for all graduates of ITE programmes in Ireland. Revised ITE programmes were due to be offered by all of the programme providers in autumn 2012. Science is not defined as a mandatory element of such programmes and there remains considerable variation between the providers regarding the time allocated to Science and the content and model of delivery of science courses.

1.5.2 Teaching approaches

In 2002 the Inspectorate of the Department of Education and Skills[1] published *Fifty School Reports: What the Inspectors Say* (Department of Education and Science, 2002b). This was based on an analysis of evaluation reports on the work of primary schools in the school year 2001-2002. In discussing teaching approaches generally, the report stated that there was insufficient use of group teaching and differentiated learning. It was reported also that there was an over-emphasis on textbooks. Each of these presented particular challenges to the implementation of practical activity-based approaches. When commenting specifically on Science, *Fifty School Reports* (Department of Education and Science, 2002b) observed that the content strands *Living things* and *Environmental awareness and care* had drawn the most favourable comments from inspectors. The report expressed concern about insufficient activity-based learning in Science and the absence of formal assessment of pupil achievement in Science.

[1] Formerly the Department of Education and Science, and hereinafter 'the Department'

1.6 Support for implementation

1.6.1 *Science: Teacher Guidelines*

A range of actions was taken by the Department to support the implementation of the science curriculum. In addition to copies of the science curriculum, all teachers received *Teacher Guidelines* for the subject, which contained extensive practical advice regarding the implementation of the curriculum. The *Teacher Guidelines* suggested approaches to planning for Science at whole-school and classroom level. They offered advice on how to approach the various strands, strand units and skills sections of the curriculum and included over forty exemplars of effective practice. The *Teacher Guidelines* also contained advice on the equipment and materials that were required to implement the curriculum.

1.6.2 Support services

An extensive programme of professional-development opportunities for teachers was funded by the Department, to support them in the implementation of the science curriculum. The planning and delivery of this support recognised that the introduction of the science curriculum was a major innovation and a phased programme was used to build capacity in the subject among teachers and schools. From September 2000 to June 2002, the Primary Curriculum Support Programme (PCSP) provided support for almost 300 schools as part of a developmental project to build capacity for the implementation of the science curriculum. Two one-day in-service seminars were provided for all primary-school teachers in the 2002-2003 school year. Schools were also allowed to close for one day to enable the teachers to engage in whole-school planning for Science. The School Development Planning Service (SDPS) provided seminars to teachers on planning matters.[2]

Schools were required to commence implementation of the science curriculum in September 2003. The PCSP provided a team of *cuiditheoirí* (curriculum advisors) to give advice and support, on request, to schools. In the first year of implementation, there were twelve *cuiditheoirí* dealing solely with Science. From 2004 on, each of the *cuiditheoirí* provided support for more than one subject. The level of *cuiditheoir* support available for Science varied from year to year. In the school year 2006/2007, there were thirteen *cuiditheoirí* who had Science as one of their subjects. Since the support services were amalgamated in 2008 schools have not been able to receive subject-specific support in Science.

1.6.3 Funding for science equipment

Most of the equipment and materials required for Science are non-specialist items that are easily obtained and can be used for practical activities in other subjects. Nevertheless, in

[2] In September 2008 the Primary Curriculum Support Programme (PCSP) and the School Development Planning Service-Primary (SDPS) were subsumed into the Primary Professional Development Service (PPDS). This, in turn, was subsequently subsumed into the Professional Development Service for Teachers (PDST).

September 2004 the Department issued a science grant of €7 million to primary schools towards the purchase of science equipment. Each school received €1000 plus €100 per pupil.

1.6.4 Science initiatives and projects in primary schools

Irish primary schools have opportunities to participate in a range of science-related projects and initiatives. Many of these involve the schools in collaboration with local science-based industries. Some of the projects provide induction days and other valuable professional-development opportunities for the participating teachers. The following is a small sample of the projects that attract high levels of participation from schools all around Ireland.

Discover Primary Science and Maths is a project of Discover Science & Engineering (DSE), Ireland's national science-promotion programme. It facilitates teacher training in general primary science, and provides teachers with useful online resources and classroom activity packs. At the time of writing over 3,100 primary schools and their teachers were participating in activities including hands-on induction days which were hosted throughout the country in colleges of education, institutes of technology, universities and education centres.

The **Science, Technology and Engineering Programme for Schools (STEPS)**, which was set up in 2000, aims to foster an enthusiasm for science and engineering while also promoting engineering as a career choice. It is particularly supportive of the *Designing and making* section of the curriculum.

The **An Taisce Green Schools Programme** aims to increase awareness of environmental issues through classroom studies and to transfer this knowledge into positive environmental action in the school and also in the wider community. The schools participate by reducing litter and waste, conserving energy and water and promoting a safe means of walking and cycling to school. At the time of writing, over 3,500 primary, secondary and special schools in Ireland were participating in the programme and 2308 schools had been awarded the Green Flag.

1.7 Report structure

The Inspectorate's evaluation of Science in the primary school was designed to examine the extent to which the aims and objectives of the *Primary School Curriculum* were being achieved in schools. Chapter 2 describes the procedures and methodology employed to gather and analyse data. Chapter 3 outlines the findings in relation to whole-school planning and classroom planning for Science. Chapter 4 reflects on the quality of teaching and assessment practices in Science, with an evidence base consisting of inspectors' observations of lessons, interviews and document reviews. Chapter 5 presents the findings on pupils' learning in Science. Chapter 6 provides a summary of main findings and recommendations.

Chapter 2
Evaluation methodology

2.1 Purpose of the evaluation

The Inspectorate's evaluation aimed to answer two key questions:

1. ***Is the science curriculum being implemented effectively?***
   The evaluation sought to ascertain the quality of teaching and learning in Science. In particular, the evaluation attempted to establish if pupils were achieving the objectives of the science curriculum. Therefore, as well as gathering evidence of the teaching approaches used, the evaluation team gathered data about pupils' achievement in science tasks.

2. ***What actions would improve the quality of learning and teaching in Science?***
   The evaluation sought to identify how the teaching of Science could be improved. The primary source of data was the evidence-based judgements made by inspectors in classrooms and schools. This was supplemented by conducting interviews with principals, teachers and science co-ordinators in each of the schools evaluated to generate their views of Science and its implementation in schools.

2.2 Schools participating in the evaluation

The evaluation was conducted during 2007 in a sample of forty schools, in place of whole-school evaluations (WSE) that were scheduled to take place in these schools. The school evaluations had a dual focus, with Mathematics being evaluated also. The selected schools were informed of the focus of the inspection three weeks prior to the commencement of the in-school evaluation. The sample included a mix of urban and rural schools, and co-educational and single-sex schools, as well as several schools that were designated disadvantaged. In order to ensure that a sufficiently large evidence base was used for the evaluation, all of the schools had at least five mainstream class teachers. Teaching and learning in Science was observed and evaluated in 215 classroom settings.

2.3 The in-school evaluation

2.3.1 Research activities

Evidence was gathered through

- Completion of a school-information questionnaire by the school principal
- Examination of planning and recording for science at whole-school level and classroom level
- Inspection of school resources for Science
- Interviews with the school principal, science co-ordinator and a sample of class teachers
- Observation of science lessons
- Administration of pupil-assessment tasks.

A set of evaluation tools (including interview and observation schedules) was produced to support the inspectors in these activities. Two schools were evaluated in a preliminary phase of the evaluation in autumn 2006. On the basis of this experience, research activities were modified slightly in advance of the main phase of evaluation activity.

2.3.2 Observation of science lessons

A preliminary meeting was convened with the teachers in each school prior to the evaluation. At this meeting details of the evaluation, including the specific strands of the curriculum that would be evaluated in each class, were discussed with the staff. To ensure that there was breadth and balance in the sample of lessons seen, each teacher was asked to prepare a lesson from a particular content strand. A quarter of all teachers observed were asked to prepare a lesson in *Designing and making*.

In schools with eight class teachers or fewer, a science lesson was observed in every classroom. A Mathematics lesson was also observed in each classroom by a second inspector. In schools with nine or more class teachers, a science lesson was observed in at least half of the classrooms and Mathematics was evaluated in the remaining classes. Each teacher observed was given informal feedback by the inspector after the lesson.

2.3.3 Tasks to assess pupil achievement

A range of pupil tasks was administered as part of the evaluation. These tasks did not constitute a standardised test and the outcomes should therefore be treated with a degree of caution. A standardised test to measure achievement in Science is not available for Irish primary school pupils at present and the standardisation of the tasks was beyond the remit and resources of the Inspectorate evaluation. However, the tasks used were based on the objectives of the *Primary School Curriculum* and provided some indication of the extent to which pupils had achieved the curriculum objectives.

This was the first Inspectorate evaluation in which there was extensive use of pupil tasks to assess achievement of specific curriculum objectives. Comparable evidence for Science or other subjects of the *Primary School Curriculum* does not exist. It was possible, however, to compare evidence regarding pupil achievement in different strands and strand units and between content strands and skills sections. The data presented here also provides a useful reference point for future studies.

Finally, by directing attention towards the extent to which pupils were demonstrating achievement of curriculum objectives the evaluation also provided schools with a reminder of the importance of basing their programmes, lessons, activities and projects on the *Primary School Curriculum*.

The inspectors administered two types of assessment task to pupils. A bank of forty-four assessment tasks was developed to assess the pupils' conceptual understanding. Tasks from this collection were administered to 2,812 pupils. Three further tasks were designed to assess the pupils' procedural understanding. 1,813 pupils in second, fourth and sixth classes each completed one of these tasks. Inspectors were given guidelines regarding the selection, administration and marking of these tasks.

The first set of tasks was used to assess the pupils' conceptual understanding. The purpose of these tasks was to establish if pupils had achieved the objectives of the four content strands of the science curriculum. The curriculum sets learning objectives for each two-year period: infants; first and second class; third and fourth class; fifth and sixth class. The inspectors administered tasks to assess the pupils' conceptual understanding in the second year of each two-year period. The selection of these classes increased the likelihood that pupils would have achieved the objectives being tested. The tasks administered in each classroom were always from a strand other than the one on which the teacher based his/her lesson. Sample tasks used to assess the pupils' conceptual understanding are shown in Tables 2.1 and 2.2.

Table 2.1: Sample task for senior infants

Class:	Infants	**Strand:**	*Energy and forces*
		Strand unit:	*Magnetism and electricity*
Curriculum objective	The child should be enabled to identify some household appliances that use electricity.		
Task:	Pupils are given pictures of five household objects. It is confirmed that all pupils recognise the objects. Pupils are asked to circle the things that use electricity.		
Indicator(s) of achievement:	Pupil circles the refrigerator, toaster and table lamp (but not the chair or the teapot).		

Table 2.2: Sample task for sixth class

Class:	Fifth and sixth	**Strand:**	*Materials*
		Strand unit:	*Properties and characteristics of materials*
Curriculum objective	The child should be enabled to identify natural and manufactured materials and understand how some of these materials are processed or made.		
Task:	Pupils are asked to identify two natural materials and two manufactured materials that can be found in the classroom. They are asked to explain in words or pictures where each of the natural materials comes from.		
Indicator(s) of achievement:	Pupil identifies two natural materials and two manufactured materials explains the origin of the two natural materials		

A second set of tasks was used to assess the pupils' understanding of science procedures, with a particular focus on the development of investigation skills. The purpose of these tasks was to establish if the pupils had achieved some of the key objectives of the *Working scientifically* section of the curriculum. These tasks were administered in second, fourth and sixth classes. The task for pupils in second class was to determine if they could identify one or two variables with guidance from the teacher. Each pupil worked on his/her own to identify possible reasons why one apple tree could grow big and healthy while another identical tree planted in the same garden in the same year could be small and unhealthy. The tasks in fourth and sixth classes aimed to establish if the pupils could design and plan simple investigations and realise that an experiment is unfair if relevant variables are not controlled. The pupils worked in mixed-ability groups to outline a practical way of investigating and resolving a particular issue that was based on the curriculum objectives for their class level. Fourth-class pupils were asked to design and plan an investigation to find out if seeds need light in order to germinate. Sixth-class pupils were asked to design and plan an investigation to find out which of several paper towels supplied was the most absorbent.

2.4 Post-evaluation procedures

The key findings of the school evaluations were presented by the inspectors at meetings with the teaching staff and the chairperson of the board of management. Each school received a written report on the quality of its provision in Science and Mathematics. These reports were subsequently published on the web site of the Department.

Evidence gathered in relation to Science, including observation and interview schedules, records of pupil achievement and school information, was collated and analysed for the purposes of writing this composite report.

2.5 Qualitative and quantitative terms used in this report

Table 2.3 lists the common quantitative terms used during the writing of this report and table 2.4 describes the quality continuum used by inspectors in the assessment of the various aspects of the work of each school and the lessons observed.

Table 2.3: Quantitative terms used in this report

Quantitative terms used	Percentages
Almost all	More than 90%
Most	75-90%
Majority	50-74%
Fewer than half	25-49%
A small number	16-24%
A few	Up to 15%

Table 2.4: The levels of the quality continuum and corresponding qualitative terms

Level	Approximate operational level	Additional terminology
4	Significant strengths	Very good; highly commendable; of a very high quality; highly effective; very successful; few areas for improvement
3	Strengths outweigh weaknesses (more strengths than weaknesses)	Good; effective practice; good quality; valuable; competent; fully appropriate provision but some areas impacting on student learning require improvement
2	Weaknesses outweigh strengths (more weaknesses than strengths)	Scope for further development; fair; provision has evident weaknesses impacting on student learning
1	Significant weaknesses (uniformly weak)	Poor; unsatisfactory; insufficient; ineffective; requiring significant change, development or improvement to improve student learning; experiencing significant difficulties

Chapter 3
Planning for Science

3.1 Introduction

The successful implementation of the science curriculum requires effective planning by schools and teachers. The whole-school planning process enables each school to take ownership of the curriculum and to devise strategies for its implementation that are tailored to the specific needs and resources of that school. At the level of classroom planning, teachers are required to prepare long-term and short-term plans that are based on the curriculum and on the guidance provided in the whole-school plan. They are also required to document the work completed in monthly progress records. These records help the school to ensure progression and continuity in pupils' learning as they move from one class to another. They also enable in-school management to monitor and support curriculum implementation. Progress records and assessment information should provide the basis for planning of subsequent lessons and activities.

This chapter presents the findings regarding whole-school planning in each of the schools evaluated and classroom planning in 215 individual classrooms. Evidence from the review of planning documentation was supported by data generated through semi-structured interviews with principals, planning co-ordinators and teachers.

3.2 Whole-school planning

3.2.1 The planning process

All of the schools evaluated had devised whole-school plans for Science and most teachers had been involved in the planning process. School principals or science co-ordinators within the school usually managed the drafting of the plan. Many schools contacted their local curriculum advisor (*cuiditheoir*) to support them in this work. The majority of schools had reviewed the school plan in the period prior to the evaluation.

Almost all of the school plans examined were based on the templates provided by the support services. This ensured that the plans usually included statements on the key issues regarding implementation of the science curriculum. The majority of plans (70%) made reference to the professional development of staff in Science and in most schools teachers had attended courses in Science organised by local education centres or through initiatives such as Discover Primary Science.

A small number of schools had devised school plans that were very specific to the school's circumstances and provided useful guidance to the staff. Many of the school plans, however, were generic in nature and had not been adapted to the specific circumstances of the school. In some cases inspectors reported that the production of the school plan seemed to have been regarded as an end in itself rather than as a means of improving the work of the school. This issue has been documented already in previous Inspectorate publications and is reflected in the following observation by an inspector during this evaluation.

> The school plan is generic in nature – if one deleted the name of the school it would not be apparent from the text that this plan was devised for this staff or for the particular context of the school or the environment. As a result, it is not clear what sense of ownership the teachers have of the plan or the relevance it has for their particular work.

3.2.2 Planning for the use of resources

Local environment

One of the important aspects of the science curriculum and of the whole-school plan for Science is the emphasis placed on the exploration of the local environment (Department of Education and Science, 1999a, p.27).

Inspectors found that half of the schools evaluated had conducted an 'environmental audit' outlining the habitats available for study in the school grounds and the wider locality. In some schools, science trails had been designed by the staff. Where this good practice was in evidence, the whole-school plan indicated how community resources, such as local science-based industries, would be used in the implementation of the school programme. It also made reference to the various projects and initiatives in which the school participated and linked each of these with specific curriculum objectives.

In half of the schools evaluated there was considerable scope for development in whole-school planning for the use of the school environment. Fewer than half (39%) of the schools had developed science trails in the school grounds or the locality. In some instances, inspectors noted that schools that were located in areas rich in natural and physical resources did not include any specific reference in their science plans to these resources or did not outline in the plans how the environment could be used. Less than 20% of schools had included a conservation code in the whole school plan.

Material resources

The provision of a range of resources is necessary to enable pupils to undertake investigations in Science. The majority of whole-school plans contained policy statements regarding the purchase, storage, use and replacement of equipment and materials. The majority of school plans indicated that a science co-ordinator was responsible for the management of these resources.

Seasonal change

While many teachers and principals expressed their confidence in teaching about *Living things* and the local environment, their school plans did not reflect the priority that schools reported that they attached to this area. Half of the school plans did not make reference to how the pupils would be enabled to observe and learn about seasonal change in the local environment.

Projects and other initiatives

Many of the schools evaluated were involved in the Green Schools programme or the K'Nex Challenge (part of the STEPS programme). However, in most cases, the school plan did not refer to these initiatives or link this work to whole-school programmes for *Environmental awareness and care* and *Designing and making* respectively. In many schools these and other projects were conducted as discrete activities and there was a lack of awareness of their potential to support the achievement of curriculum objectives.

3.2.3 Planning for a broad and balanced curriculum in Science

Where very good practice was observed, inspectors noted that the school plan reflected the language and structure of the 1999 curriculum. In almost all schools the whole-school plan included references to each of the strands. Schools generally adhered to the recommended time allocation for Science.

However, in one fifth of schools, the school plan did not provide for the study of each strand unit over a two year period, as recommended in the curriculum. This was considered by inspectors to be an impediment to progression and continuity in pupils' learning of key concepts. A significant number of whole-school plans (30%) did not identify the concepts to be targeted. While most schools listed the skills that would be developed, the activities through which they would be developed were not outlined. Almost two-fifths of schools (38%) had not planned for regular *Designing and making* activities. This limited pupils' access to the full repertoire of skills outlined in the curriculum. In over two-fifths (43%) of schools, the school plan did not include planning for progression in pupils' learning as they moved from one class to another.

Almost all of the school plans contained statements endorsing the learning principles of the science curriculum. Inspectors found that school plans made good provision for most of the significant methodologies referred to in the curriculum. However, school plans were weakest in significant areas such as planning to use children's ideas appropriately and the use of open-ended investigations.

Almost all of the whole-school plans made reference to the importance of starting all lesson and activities with children's ideas, in accordance with the curriculum. However, only 58% of the plans provided guidance for teachers regarding how to elicit pupils' ideas at the various class levels. Only half of the whole-school plans promoted the use of open-ended investigations as a teaching approach. These findings raised concerns about the extent to

which pupils in the schools evaluated were being enabled to articulate, test and change their scientific ideas, to investigate and to solve problems.

3.2.4 Co-ordinating the planning and teaching of Science in schools

Where whole-school planning for Science was very good, the whole-school planning process was usually co-ordinated by a science co-ordinator, whose role was explicitly outlined in the school plan. In larger schools the science co-ordinator was also a member of the in-school management team and had leadership and management responsibilities. The co-ordinator also led the development and use of the school grounds as a resource for the teaching of Science and co-ordinated the school's science equipment and materials. In some schools, the co-ordinator kept staff informed of courses, projects and other professional-development opportunities in Science. Some co-ordinators organised resources for the various strand units of the curriculum for each class level.

In a small number of schools the science co-ordinator was responsible for supporting and monitoring the implementation of Science at the different class levels. Where this practice was established, the whole-school plan identified a clear strategy for co-ordinating and monitoring the school's work in Science and indicated how pupil outcomes were to be assessed. However, the potential of the science co-ordinator's role in leading, supporting and monitoring the implementation of the school plan for Science was realised in only a small number of schools.

Table 3.1: Summary of findings regarding whole-school planning

Findings of good practice
• There was widespread involvement of teachers in the whole-school planning process. • Almost all of the school plans reflected the structure and language of the *Primary School Curriculum*. • There was effective planning for the provision and management of science equipment and materials. • Schools had availed of a range of visiting experts to enhance their science programmes.
Concerns
• Many of the school plans did not describe the practical actions the school would take to implement the key principles endorsed by the plan. • Half of the whole-school plans did not make provision for open-ended investigations in the science programme planned. • Insufficient attention was given to the development of skills and progression in skills development from class to class. • The majority of school plans for Science did not provide a specific plan for the use and development of the local environment as a resource for learning. • Very few of the plans indicated how the school's participation in various projects was linked to the achievement of curriculum objectives. • Very few schools had developed the role of the science co-ordinator to the point where it provided effective curriculum leadership.

3.3 Classroom planning and preparation

Where classroom planning was considered to be good or very good, inspectors found that it was based on the curriculum, the school plan and the needs of the pupils. Teachers' long-term planning clearly identified the strands and strand units of the curriculum that were to be covered. The objectives from the skills sections of the curriculum (*Working scientifically* and *Designing and making)* were included, as well as objectives from the content strands. Teachers ensured that the topics covered under the various strand units built on the pupils' previous understanding. Teachers indicated in their planning how the programmes and lessons would be adapted to the needs of individual pupils, and how Science would be integrated with other curricular areas. These characteristics are reflected in the following extract from an inspector's report.

> The long-term plan outlines the strands and strand units that will be covered during the term. Work in a specific strand unit is covered each month. The teacher outlines the content objectives in terms of skills and knowledge that she will explore under each strand unit. This ensures that the objectives of the curriculum are being taught in an incremental way and opportunities for skill development in each content area are highlighted. The plan outlines the methodologies that will be used such as talk and discussion, active learning, problem solving, skills development through content, use of the environment. The teacher has planned a range of integrated SESE themes.

The following table presents inspectors' findings regarding particular aspects of individual teachers' planning.

Table 3.2: Inspectors' evaluation of classroom planning

Aspect of planning	% of plans that were good/very good	% of plans that were poor/fair
Time allocation to Science	87%	13%
Planning based on strands and strand units	77%	23%
Planning for integration	75%	25%
Specific short-term objectives	58%	42%
Long-term planning for skills development	56%	44%
Short-term planning for skills development	46%	54%
Planning for individual needs	39%	61%

Time allocation for Science

It was evident, from weekly timetables and short-term plans, that most teachers (87%) allocated at least one hour in their weekly timetable to the teaching of Science, as recommended in the *Primary School Curriculum* (Department of Education and Science, 1999a). Some teachers reported that they always exceeded the time allocation in order to cover the programme. The preparation and management of equipment and materials, and the

organisation of activities for multiple classes were considered to present particular challenges for time management. It was observed by some teachers that a weekly one-hour session was not always the most useful way of organising certain science activities, especially in *Designing and making*. While all of the teachers interviewed found it helpful to integrate Science with other areas of the curriculum, they reported that this required a more flexible approach to the weekly timetable. Some teachers 'blocked' periods of time for SESE, covering the three subject areas over alternate weeks. Most (75%) of the planning for integration between Science and other subjects was judged to be either good or very good.

Balance between knowledge and skills

Most (77%) of the class programmes examined by inspectors during this evaluation were structured according to the content strands and strand units of the *Primary School Curriculum.* This was seen as a positive indication of teachers' familiarity with this dimension of the curriculum.

One of the key weaknesses identified by inspectors in short-term planning was the lack of emphasis on specific learning outcomes. Good or very good practice in setting specific short-term objectives was identified in just over half (58%) of the classroom plans examined.

Inspectors judged that more than half of the classroom teachers were not placing sufficient attention on the development of science skills in their planning. In many cases, the plans did not indicate which of the objectives from *Working scientifically* or *Designing and making* were to be achieved by the pupils during the period covered by the plan. If the specific skills to be acquired are not identified clearly by the teacher in advance of the lessons, then there it is unlikely that there will be adequate opportunities for pupils to develop these skills.

The role of the pupils' textbook

In almost two thirds of classrooms, inspectors considered that the pupils' textbook was used appropriately. The programme was based on curriculum objectives and the pupils' textbook was used as one of many resources to support practical work. However, inspectors judged that in one third of classrooms, textbooks had an undue influence on the Science programme that was planned. Where planning was evaluated as poor or fair, it was noted frequently that the structure and content of the programme or lesson were determined by the pupils' textbook and that there was little or no reference to curriculum objectives or the school plan. Such over-reliance on textbooks was an impediment to curriculum implementation and meant that opportunities for pupils to engage in discovery learning, scientific experiments and exploration of the environment were diminished.

Planning for individual differences

This evaluation found that provision for individual pupils was the weakest aspect of teachers' planning for Science. Fewer than half (39%) of the plans examined made good or very good provision for individual needs. In the last decade, the range of learning needs in mainstream classes has broadened significantly because of the inclusion of large numbers of pupils with

special educational needs and pupils who are learning English as an additional language. These developments mean that there is a greater need than ever for teachers to adapt their programmes and lessons so that the particular needs of individual pupils are met. Inspectors found that, while pupils with special educational needs often had special-needs assistants or particular equipment, it was frequently the case that the science lesson or the class programme had not been adapted for these pupils. Planning for Science in 60% of classrooms did not recognise and respond to the educational needs and experiences of pupils of differing abilities.

Monthly progress records

Inspectors reported that most teachers maintained monthly progress records, as required by the Department. Practice in this regard was considered to be good or very good in 40% of classrooms. In these cases, teachers had set out learning targets prior to teaching and used the monthly progress records to record the learning outcomes achieved by the pupils. Where practice was considered by inspectors to be fair, teachers recorded the name of the topic or unit or work without further information. Less than half of the teachers observed made reference in their monthly progress records to the skills the pupils had developed. This made it difficult for the school to monitor progression in skills development.

Table 3.3: Summary of findings regarding classroom planning and preparation

Findings of good practice
• Time allocation for Science was in accordance with the *Primary School Curriculum.* • There was effective planning for integration with other subject areas. • Classroom planning was structured according to the content strands and strand units of the *Primary School Curriculum*.
Concerns
• The identification of specific learning objectives was considered to be good or very good in only half of the short-term plans examined. • Planning for skills development was fair or poor in approximately half of classrooms. • In some cases, the structure and content of class programmes and lessons were determined solely by the pupils' textbook. • Planning for individual needs was fair or poor in over 60% of classrooms.

3.4 Key findings and recommendations regarding planning for Science

3.4.1 Key findings regarding planning for Science

In most schools, significant progress had been made in whole-school planning and classroom planning for Science. There was evidence of effective collaboration between teachers in devising the whole-school plan. Almost all of the school plans and the individual classroom planning examined during the evaluation reflected the structure and language of the science curriculum and restated the key principles of the curriculum. Almost all schools had set a date

to review their school plans and had nominated a teacher to co-ordinate the provision of science in the school.

The practical nature of Science and its links with the other SESE subjects can present challenges for the management of time and other resources. It is clear, however, that schools and teachers were generally very successful in managing the equipment and materials that are necessary for the implementation of the curriculum. There was effective planning at classroom level for integration of Science with other subjects. The majority of schools made use of a range of visiting experts whose work with teachers and pupils enhanced and enriched the schools' science programmes.

This evaluation also identified scope for development in planning for Science. There was a need for schools to place a greater emphasis on designing and implementing whole-school plans that provide practical guidance for teachers in the teaching of Science. In particular, there was scope for more effective planning for the development of children's existing ideas and procedural skills, and for use of the local environment. The identification of clear learning outcomes in short-term planning and the differentiation of programmes and lessons for the particular needs of individual pupils were also areas in which the evaluation identified room for improvement.

3.4.2 Recommendations regarding planning for Science

In-school management

- Designating a teacher to provide effective curriculum leadership in Science at school level can have a very beneficial effect on the quality of school planning and curriculum implementation in the subject. Schools should consider designating a teacher as a Science co-ordinator for this purpose.
- The role of science co-ordinator in schools should include responsibility for developing and monitoring the implementation of the school plan for Science, co-ordinating the development and use of the school grounds and co-ordinating the professional development of the staff.

The content of the school plan

- Schools should ensure that the whole-school plan for Science records accurately the good practice that has been developed in response to the particular needs of the school and the resources available locally.
- In particular, all whole-school plans for Science should include strategies that teachers will use to elicit and record pupils' ideas and to enable pupils to undertake open-ended investigations.
- Schools should ensure that the whole-school plan for Science provides a basis for the co-ordinated use and development of the school's immediate environment as a resource for learning in Science.

- Activities in the local environment and participation in projects such as the Green Schools initiative should be linked clearly in the school plan with particular curriculum objectives.

Classroom planning

- Teachers should endeavour to ensure that their classroom plans for Science give adequate attention to the *Working scientifically* and *Designing and making* sections of the curriculum as well as the four content strands.
- Teachers should base their science programmes and lessons on curriculum objectives and the needs of pupils, rather than the content of any one pupils' textbook. Textbooks may then be used, as relevant, to support the achievement of relevant learning targets.
- Classroom planning should identify clearly the intended learning outcomes to be achieved and monthly progress records should provide details of the learning that has taken place.
- Teachers' classroom planning for Science should always indicate how teaching will be differentiated for pupils with particular individual needs. Schools and teachers will find *Guidelines for Teachers of Students with General Learning Disabilities* (NCCA, 2007) useful in this regard.

Chapter 4
Quality of teaching in Science

4.1 Introduction

Many of the principles that underpin good science teaching apply to learning and teaching in general. These include the importance of adapting the curriculum to the pupils' interests, needs and strengths, and providing a supportive classroom environment where co-operation, shared responsibility and respect are promoted. Key principles that are specific to science education as envisaged in the *Primary School Curriculum* were set out in Chapter 1 of this report. The extent to which these principles were being implemented in classrooms was a major focus of this evaluation.

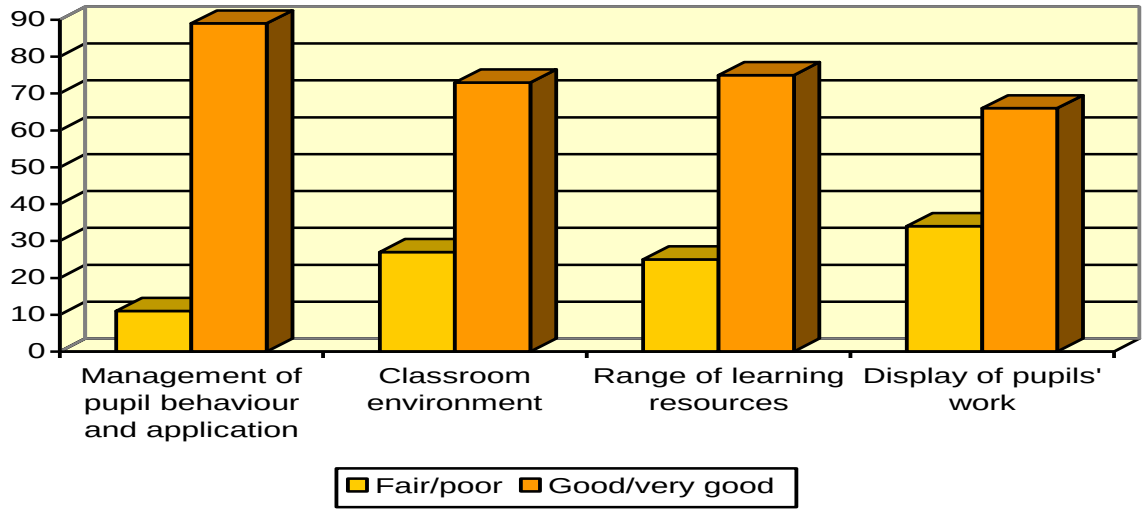
Inspectors observed 215 science lessons, with an even distribution across the four content strands of the science curriculum. Approximately one quarter of all lessons observed were in *Designing and making*. The evidence base for this chapter was gathered through the use of classroom-observation schedules and supplemented through interviews with principals, science co-ordinators and class teachers. The evidence and findings are presented under three headings:

- Classroom atmosphere and management
- Quality of teaching
- Quality of assessment and record keeping

4.2 Classroom atmosphere and management

The inspectors' observations on this area of quality were very positive. It was clear that most teachers were very successful in providing a classroom environment that supported learning in Science.

Figure 4.1: Inspector's evaluation of aspects of classroom management



In most (89%) of the lessons observed, the management of pupils and their engagement with the tasks were judged to be good or very good. Science lessons incorporated an effective blend of whole-class, group and individual activities. Inspectors reported that almost all lessons were interesting and challenging for the pupils. There was a strong sense of purpose and engagement, with a lot of structured interaction. Where very good practice was observed, inspectors noted that pupils were encouraged to express their views and to test and develop their own ideas.

Most (75%) of the lessons observed also involved the use of an appropriate range of learning resources. It was clear that the funding provided by the Department for equipment had been spent appropriately and that resources were managed effectively. Where effective practice was in evidence, classrooms had charts and various other displays that made it easier for the pupils to understand and remember what was taught. There were also displays of annotated drawings, concept maps and other work done by pupils.

The physical organisation of the classroom enabled pupils to work in groups on practical tasks as necessary. There was easy access to appropriate equipment and materials. Many classrooms had a science table or investigation table with resources that were relevant to current or recent lessons.

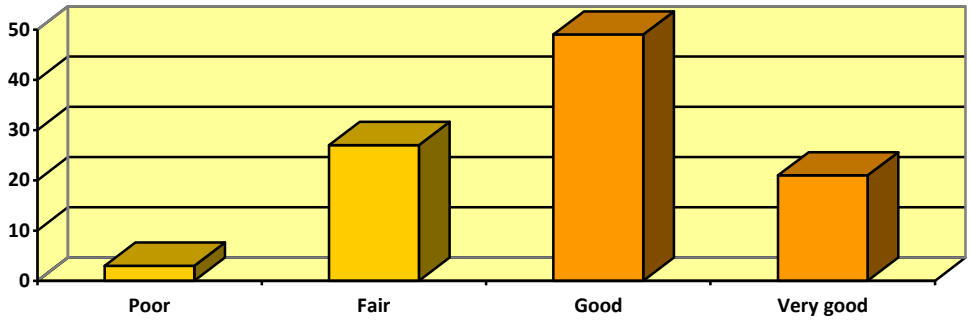
Classroom displays are of great importance in the learning process. They can be used to stimulate the pupils' curiosity about the physical world, enable them to reflect critically on their own ideas and support the development of their procedural understanding. The display of pupils' work in Science was fair or poor in one third (34%) of classrooms.

Table 4.1: Summary of findings regarding classroom atmosphere and management

Findings of good practice
• Management of pupil behaviour and their application to tasks was good or very good during 89% of the lessons observed. • The range of learning resources provided was good or very good in 75% of lessons observed.
Concerns
• The display of samples of pupils' work was fair or poor in 34% of classrooms.

4.3 Quality of teaching

Figure 4.2 % of lessons observed at each quality level



The overall quality of the science lessons observed was good or very good in two-thirds of classrooms. While the overall picture is very positive, there is evidence of scope for development in key areas of teaching. In a small number of classrooms, inspectors identified significant difficulties.

Inspectors found that very good generic teaching skills were in evidence in science lessons. Most of the lessons (84%) were appropriate for the class as a whole in terms of structure, pace and progression. A variety of methodologies, including group work, was observed in most (76%) of the lessons. The lesson objective was clearly explained in 78% of classrooms. Pupils in most classrooms were interested in the lesson taught (87%). In almost all (92%) of the lessons observed, girls and boys were considered to be participating equally in science activities. Many characteristics that are specific to good science teaching were observed in the lessons evaluated. These findings are presented in Table 4.2 and discussed further below.

Table 4.2: Inspectors' evaluation of aspects of teaching

Characteristics of good teaching	Good/very good	Fair/Weak
Teacher displays secure knowledge of science concepts and skills	86%	14%
Clarifies science concepts for pupils and encourages pupils to reflect on their ideas	79%	21%
Attention to language of science	80%	20%
Elicits children's ideas at the start of the lesson	56%	44%
Allows pupils to devise own ways of working	48%	52%
Relates science to everyday situations that have relevance to the pupils	88%	12%
Learning activities are differentiated	56%	44%

Children's ideas

The *Primary School Curriculum* emphasises the importance of using pupils' existing ideas about the world as a starting point for all science lessons and activities. It is of concern, therefore, that almost half (44%) of the lessons observed were considered to be fair or poor in this regard. Over half of the teachers observed (56%) were good or very good at eliciting pupils' ideas at the start of the lesson. In some cases, this was achieved through whole-class or group discussions. In other classrooms, pupils were asked to record their ideas in annotated drawings or concept maps.

Balance between skills and knowledge

During science lessons that were judged to be very good, teachers developed the pupils' procedural understanding and their conceptual understanding simultaneously and there was a deliberate focus on developing the skills that are listed in the *Working scientifically* section of the curriculum. Where best practice was observed, the teachers enabled the pupils to work collaboratively, to solve problems and to discuss their ideas. The pupils were given opportunities to test and develop their ideas through practical activity.

Knowledge of science concepts and language of Science

Most teachers (87%) demonstrated considerable skill in managing and communicating with pupils during the lesson. Most of the lessons observed (80%) also featured an appropriate emphasis on the language of science. Teachers explained concepts clearly and encouraged pupils to reflect on their own ideas in most (79%) of the lessons. It was evident that teachers were generally very effective in making links between science concepts and everyday

situations that had relevance for the pupils. Good practice in this regard was identified in most (87%) of the lessons observed.

Skills of Working scientifically

Inspectors judged that fewer than half (39%) of the lessons observed were good or very good in terms of enabling pupils to plan a fair test. These findings give cause for concern about the implementation of the *Working scientifically* section of the curriculum. In many instances the lessons included experiments where the outcome of the test was known in advance and where the method and materials used were decided by the teacher. In some classrooms, the teacher demonstrated or asked a small number of pupils to demonstrate an experiment.

Differentiation

The differentiation of lessons for the needs of individual pupils was good or very good in just over half (56%) of the lessons observed. Special-needs assistants and physical resources were used appropriately to support pupils with physical and other special educational needs.

Pupils devising their own ways of working

Where teaching was very effective (48%) pupils were allowed to devise their own ways of working as much as possible. They were encouraged to select materials and equipment to use in their investigations. Teachers invited pupils to suggest ways of working and supported different groups to approach the same task in different ways. At all class levels, effective teachers encouraged pupils to reflect critically on the procedures followed, with a view to developing their ability to work scientifically.

However, in just over half of the classrooms visited (52%), inspectors were of the view that the lessons observed were too teacher-directed and that pupils were not accorded the opportunities to actively engage in science learning, to suggest ideas, to devise their own tests or to suggest materials for use in their investigations. The following evaluative comments from inspectors are illustrative of this.

> These are very good experiments but they would have been much better if they were not so teacher directed and if the children had an opportunity to conduct the experiments themselves. The children spent a lot of time sitting and listening during this lesson.
>
> The lesson is wholly controlled and led by the teacher. She gives clear explicit instructions but there is no fostering of the pupils' independent skills or the development of higher-order thinking skills. The teacher uses a didactic approach and there are no opportunities for the pupils to discuss, ask questions or to explore their own questions. The teacher presented the lesson well and has a secure knowledge of the topic she was teaching but there was no effort to include scientific enquiry in the lesson.

Designing and making

There was evidence that a tendency towards too much teacher direction in the middle and senior classes was particularly problematic in the area of *Designing and making*. The ability to devise plans and work independently is critical to the pupils' ability to undertake activities in this section of the curriculum. Where lessons in *Designing and making* were very good, the teacher allowed pupils to make key decisions with regarding to planning, making and evaluating.

In interviews, a majority of teachers identified *Designing and making* as an area they found difficult. Many principal teachers also identified this as an aspect of the curriculum in which practice was weak. One third of teachers reported that they seldom or never provided activities in *Designing and making*. It was clear to inspectors in many cases that *Designing and making* was not a regular aspect of classroom work, that teachers were unfamiliar with the methodologies associated with *Designing and making* and that there was a need for a wider range of materials, tools and techniques with which pupils could choose to work.

Table 4.3: Summary of findings regarding the quality of teaching in Science

Findings of good practice
• Teachers' knowledge of the science concepts and skills that formed the focus of the lesson observed was good or very good in most cases. • Teachers' ability to communicate and clarify concepts was good or very good in most lessons. • Teachers' ability to relate Science to everyday situations that had relevance for pupils was good or very good in most lessons. • The structure and pacing of most of the lessons observed were good or very good.
Concerns
• Almost half of the lessons observed were judged to be fair or poor in terms of eliciting pupils' existing ideas. • Half of the lessons were fair or poor in terms of allowing pupils to devise their own ways of working. • Differentiation of learning activities for the needs of individual pupils was fair or poor in almost half of the lessons observed.

4.4 Quality of assessment and record keeping

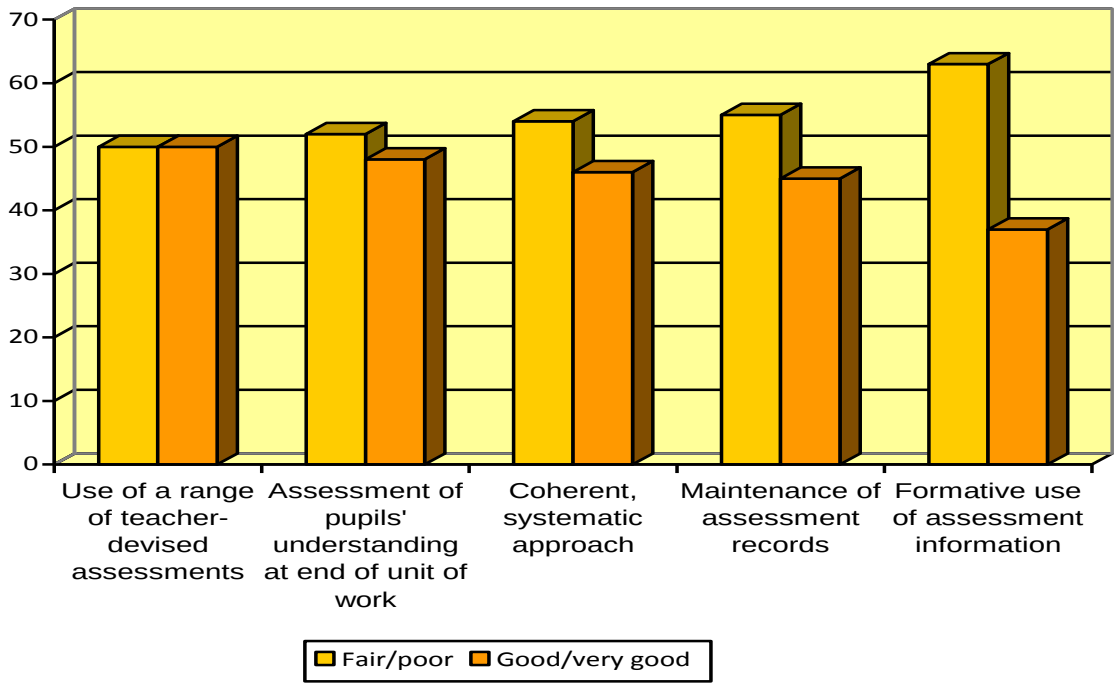
Assessment is an integral part of teaching and learning and it should assist in planning and supporting future learning for the child. The science curriculum provides practical suggestions for the assessment of Science in the curriculum statement (pp. 96-107) and in the *Teacher Guidelines* (Department of Education and Science, 1999b, pp.142-145). However, standardised assessment tools are not available for primary science in Ireland. A resource pack entitled *Hands-On Science: Tasks to Support Assessment for Learning and Teaching*

was developed for use in Irish primary schools by staff at St. Patrick's College of Education and published in 2005. This consists of a range of practical hands-on assessment tasks for use in the formative assessment of pupils' conceptual and procedural understanding.

Assessment and record keeping were the aspects of the teaching and learning process in which the greatest weaknesses in practice were observed. More than half of classroom teachers were experiencing difficulties in assessing and recording pupils' progress in Science. Learning outcomes did not receive sufficient attention in classroom planning and in monthly progress records. Fewer than half (40%) of the monthly progress records examined provided a good or very good record of the knowledge and skills taught.

There was a coherent and systematic approach to pupil assessment in Science in fewer than half (46%) of the classrooms visited. The use of teacher-devised assessments to monitor pupils' progress and achievement was good or very good in only half of the classrooms visited. The assessment of pupils' understanding at the end of a unit of work was good or very good in fewer than half (48%) of the lessons seen. Good or very good practice in maintaining records of pupils' work was observed in fewer than half (45%) of cases. Even when teachers were assessing their pupils, they were not successful in using this information to inform future learning. The use of assessment information as a basis for subsequent teaching and learning was considered to be good or very good in only 37% of cases. In one quarter of classrooms, there were significant difficulties in this regard.

Figure 4.3: Inspectors' evaluation of aspects of assessment



4.5 Key findings and recommendations regarding quality of teaching

4.5.1 Key findings regarding quality of teaching

Inspectors found that the vast majority of teachers demonstrated a secure understanding of the concepts that formed the focus of the lessons observed. Most teachers demonstrated good or very good communication skills. Teachers' expertise in classroom and lesson management was generally good or very good. Inspectors judged that lessons were generally interesting and well structured and that girls and boys participated equally in the lessons.

There is evidence that, in order to build on these strengths and continue to improve the quality of provision in Science, schools and teachers need to give greater consideration to the development of pupils' science skills, planning for learning outcomes and placing an increased focus on the individual learner.

4.5.2 Recommendations regarding quality of teaching

Focus on skills

- Teachers should plan for and assess pupils' development of the skills included in the *Working scientifically* and *Designing and making* sections of the curriculum.

- Teachers should allow pupils to devise their own ways of working, especially in the middle and senior classes, with a view to developing their procedural skills and understanding. It is particularly important that pupils in these classes be enabled to design and conduct their own investigations and to complete open-ended problem-solving tasks in *Designing and making*.

- All initial teacher-education programmes should include a practical workshop-based component to develop students' understanding of scientific concepts and their knowledge and skills in the area of Science education.

- Supporting teachers and schools in the development of pupils' procedural skills and knowledge should be a priority in the work of the support services and in the provision of online resources for Science.

Focus on learning

- Schools should assess pupil achievement in Science regularly and the results of assessment should be used to inform subsequent planning and teaching.

- The Department should consider commissioning the development of further assessment materials that are specific to the context of Science in the *Primary School Curriculum.*

- Teachers and schools should ensure that they are familiar with and implement the guidance provided in the publication *Assessment in the Primary School: Guidelines for Schools* (NCCA, 2007).

- It is recommended that support services consider providing specific support for schools in the area of assessment.

Focus on the learner

- Teachers should elicit and record pupils' existing ideas as a starting point for all science activities. The information gathered should provide a basis for teacher-pupil interactions during the lesson and for review and assessment at the end of the unit of work.

- Samples of pupils' observations, concept maps, drawings etc should be displayed in classrooms and used to monitor the development of understanding. Teachers are referred to *Teacher Guidelines* (Department of Education and Science, 1999b, pp. 142-145).

- Teachers should identify the individual needs of pupils in Science and differentiate their teaching programmes appropriately.

Chapter 5
Quality of learning

5.1 Introduction

As part of this evaluation, inspectors interacted with pupils, questioned them and examined samples of their work. They also administered written tasks to pupils. A total of 2,812 pupils were given tasks to assess their conceptual understanding. Tasks to assess procedural understanding were administered to 1,813 pupils. This chapter presents and analyses the results of these tasks. The rationale for using these tasks and the recognised limitations of the tasks are set out in section 2.3.3 of this report.

5.2 Pupils' conceptual understanding

5.2.1 Overview

The evaluation team ensured that the tasks administered were divided as evenly as possible across the four content strands of the curriculum. The number of pupils who completed tasks in each strand and the average success rate for each strand are shown in Table 5.1. There was no evidence of any significant difference in achievement between girls and boys in any strand or strand unit.

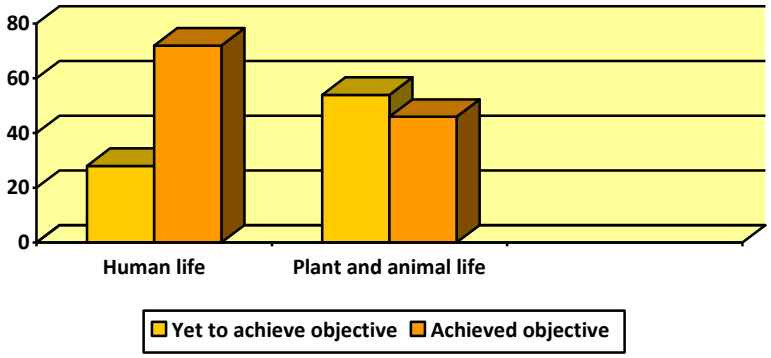
Table 5.1: Performance of pupils in tasks from each strand

Strand	No. of pupils who completed tasks	Average % of pupils who completed task Successfully
Living things	751	59%
Energy and forces	727	58%
Materials	663	69%
Environmental awareness and care	674	69%

Across the four strands, 63% of all pupils tested completed their tasks successfully, demonstrating that they understood the concepts being tested. While the differences between the four strands in terms of pupil achievement were not considerable, pupils did best in the tasks from *Materials* and *Environmental awareness and care*.

5.2.2 Pupil achievement in *Living things*

Figure 5.1: % of pupils who had achieved/yet to achieve relevant curriculum objective in Living things



Living things has two strand units at each class level. One of these deals with the variety and characteristics of human beings and their life processes. The other deals with the variety and characteristics of plants and their life processes. From infants to second class, these strand units are called *Myself* and *Plants and animals*. From third class on, these titles change to *Human life* and *Plant and animal life*, respectively.

In interviews conducted as part of this evaluation, the majority of science co-ordinators, teachers and principals identified *Living things* as a strand in which they thought the school was doing well. Teaching about plants and animals has been an established part of classroom practice for over three decades. However, data from pupils' tasks indicate that *Plants and animals* was one of the strand units in which pupils' learning was weakest.

The data from the assessment tasks suggest that the quality of pupil learning in the strand unit *Myself/Human life* was good. 72% of the pupils who were given tasks in this area completed them successfully. *Myself/Human life* is also a strand unit in the subject Social Personal and Health Education. It may be the case that the key concepts are reinforced effectively by this double emphasis. Table 5.2 shows one of the tasks completed by pupils in this strand unit.

Table 5.2: Sample task from Human life

Class:	5th & 6th	**Strand:**	*Living things*	**Strand unit:**	*Human life*
Curriculum objective:	The child should be enabled to develop a simple understanding of the structure of some of the body's major internal and external organs				
Task:	On the outline of the human body, ask the pupils to draw in four of the organs named at the top of the page. Ask them to write one or two sentences explaining the function of each of these organs.				
Indicator(s) of achievement:	Pupils can draw and name a function for four of the six organs.				

The evaluation suggested that pupil achievement in the strand unit *Plant and animal life* was much weaker than in *Myself/Human life*. Only 46% of the pupils who were given tasks in this area completed them successfully. Of all strand units across the curriculum, *Plant and animal life* was the one in which pupil achievement was weakest.

It has been acknowledged already that *Living things* "absorbs the existing nature study programme, which focuses on plant and animal life."(Department of Education and Science, 1999b, p.9). There was evidence in observation and interview schedules to suggest that many teachers did not fully understand the key differences between 'nature study' and implementing a scientific approach to the study of *Plant and animal life* and needed to become more familiar with the objectives and approaches in this strand unit.

Furthermore, the successful implementation of *Plant and animal life* requires regular opportunities for pupils to learn about their immediate outdoor environment through practical exploration and investigation. There was evidence from interviews with class teachers that pupils did not get sufficient experience of this. According to these interviews, approximately one third of pupils did not have any opportunity to participate in field trips. The concepts of the habitat and the food chain/web and the ability to use and make identification keys are central to the study of *Plant and animal life*. There was evidence from the assessment tasks that these concepts and skills had not been learned by pupils. For example, just over one quarter of the pupils who were given the task shown in Table 5.3 completed the task successfully.

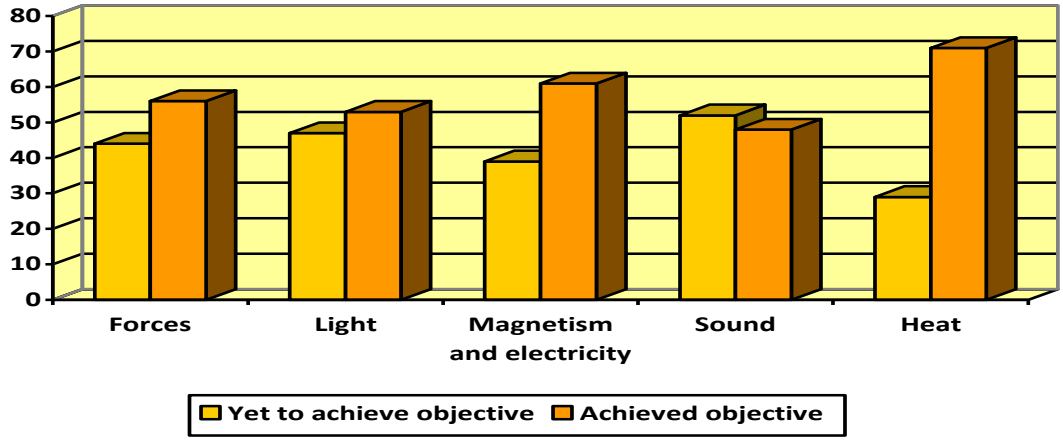
Table 5.3: Sample task from Plant and animal life

Class:	3rd & 4th	**Strand:**	*Living things*	**Strand unit:**	*Plant and animal life*
Curriculum objective:	The child should be enabled to observe and explore some ways in which plant and animal behaviour is influenced by, or adapted to, environmental conditions.				
Task:	It is explained to pupils that all living things are adapted to their environment. Pupils are asked to think, for example, of any way in which the giraffe is adapted to its habitat or diet (long neck to reach leaves on high branches; camouflage colouring; lips and teeth ideal for biting and chewing leaves) The pupil sheet has pictures of six animals: camel, whale, eagle, polar bear, duck, bat. The pupils are required to write beside *four* of the animals, two ways in which that animal is adapted to its habitat or diet.				
Indicator(s) of achievement	Pupils provide two satisfactory responses for at least four animals. eg. CAMEL: ability to go without water; specially adapted feet; can close eyelids and nostrils against sandstorms WHALE: can dive to great depths; blubber; blowhole; tail fin; mouth for sifting krill EAGLE: beak; talons; tail feathers; eyesight POLAR BEAR: camouflage; blubber; claws; teeth; swimming ability DUCK: webbed feet; waterproofing; bill BAT: wings; sleeping habits; hearing; sonar				

These findings indicate a need for a renewed focus on the objectives of *Plant and animal life* and a commitment to the approaches suggested for this strand unit in the *Teacher Guidelines* (Department of Education and Science, 1999b).

5.2.3 Pupil achievement in *Energy and forces*

Figure 5.2: % of pupils who had achieved/yet to achieve the relevant curriculum objective in Energy and forces



Teachers identified *Energy and forces* as the strand in which they were encountering the greatest difficulty. Over half (58%) of the science co-ordinators interviewed also believed that this was the strand in which teachers needed most support. *Energy and forces* contains the more abstract of the concepts included in the curriculum. Enabling pupils to learn that light and sound travel, for instance, or that objects have weight because of the pull of gravity requires a high level of skill and understanding on the part of the teacher. The report of the *Task Force on the Physical Sciences* (Department of Education and Science, 2002a) made particular reference to the fact that most primary teachers have little or no experience of the physical sciences.

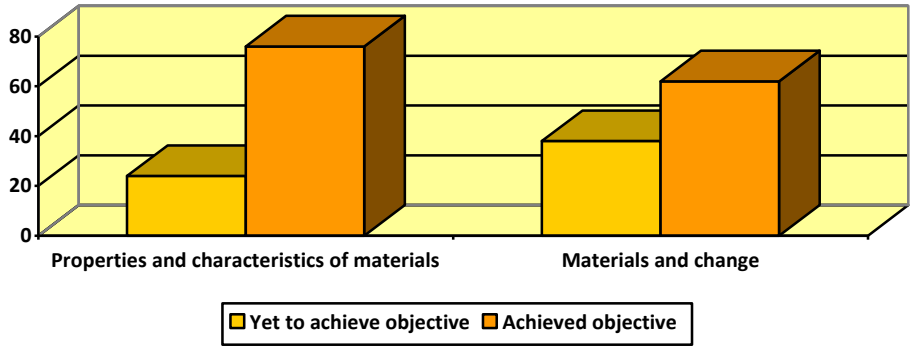
Energy and forces was the strand in which pupils were least successful in completing tasks. 58% of the pupils who were given tasks in *Energy and forces* completed them successfully. It can be seen from Figure 5.2 that *Heat* was the strand unit in which pupils experienced the most success. Just over half of the pupils had achieved the objectives in *Forces* and *Light*. Fewer than half of the pupils who were given tasks on *Sound* completed them successfully. There was evidence from interviews with teachers and principals to suggest that further professional-development opportunities in *Energy and forces* in general and in *Sound*, *Light* and *Forces* in particular should be provided for teachers. Table 5.4 shows a sample task from Energy and forces.

Table 5.4: Sample task from Energy and forces

Class:	5th & 6th	**Strand:**	*Energy and forces*	**Strand unit:**	*Magnetism and electricity*
Curriculum objective:	The child should be enabled to investigate current electricity by constructing simple circuits…experiment with simple switches				
Task:	Pupils are shown two drawings. The first picture shows a simple circuit with battery, bulb, wire and a paper-clip switch that is in the open position. The second picture shows the same circuit with the paper-clip switch in the closed position. Ask pupils to write down in which picture the bulb would light and to use words and/or pictures to explain why.				
Indicator(s) of achievement	Pupil understands that the bulb will only light in the second picture, because the switch is closed/on, completing the circuit.				

5.2.3 Pupil achievement in *Materials*

Figure 5.3: % of pupils who had achieved/yet to achieve the relevant objective in the strand Materials



Overall, pupil achievement in this strand was good. In the strand unit *Properties and characteristics of materials,* 76% of pupils tested completed the tasks successfully. Table 5.5 shows a task used by the inspectors to assess pupils' learning in *Properties and characteristics of materials.*

Table 5.5: Sample task from Properties and characteristics of materials

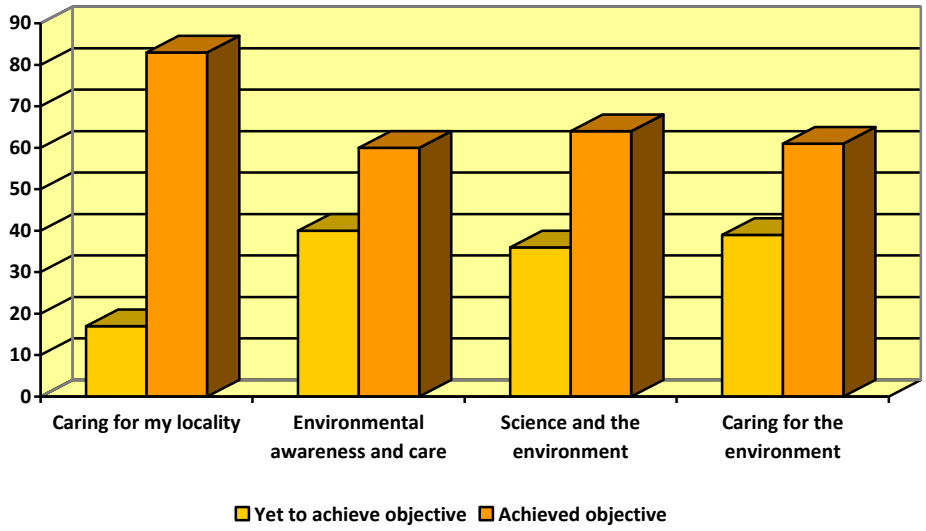
Class:	1st & 2nd	**Strand:**	*Materials*	**Strand unit:**	*Properties and characteristics of materials*
Curriculum objective:	The child should be enabled to identify and investigate a range of common materials used in the immediate environment.				
Task:	Ensure that pupils recognise objects shown. Ask the pupils to i. Circle the things that are usually made from metal. ii. Circle the things that are usually made from wood. iii. Circle the things that are usually made from plastic. iv. Circle the things that are usually made from paper. v. Circle the things that are usually made from glass.				
Indicator(s) of achievement	Pupil circles the correct pictures in at least four out of five rows.				

The success rate was not as high in the strand unit *Materials and change,* in which 62% of pupils completed the tasks successfully. On average across the two strand units of *Materials*, 69% of pupils completed the tasks successfully. One possible reason for this difference between the two strand units is that some of the language and concepts of *Properties and characteristics of materials* are reinforced by work in other curricular areas. Objectives that require pupils to describe, compare and group objects are reinforced by similar emphases in the Mathematics curriculum. Also, language and vocabulary are central to the achievement of many of the objectives in *Properties and characteristics of materials* and this evaluation found that teachers were generally very effective in teaching the language of Science. There is an emphasis, especially in the junior and middle classes, on being able to name materials and describe their properties.

5.2.5 Pupil achievement in *Environmental awareness and care*

The quality of pupils' learning in this strand appeared to be good. As in the strand *Materials,* 69% of pupils completed the tasks successfully. As shown in Table 1.1 earlier in this report, *Environmental awareness and care* has only one strand unit, *Caring for myself and my locality* from infants to second class, and three strand units from third to sixth class. The percentage of pupils who completed tasks successfully in each of the four strand units is shown in Figure 5.4.

Figure 5.4: % of pupils who had achieved/yet to achieve objective in Environmental awareness and care



Overall, pupil achievement in this strand was better than that in *Living things* and *Energy and forces*. There are several possible reasons for this. *Environmental awareness and care* forms a strand in the Geography curriculum as well as the science curriculum and the key concepts would be reinforced more frequently than most of the concepts in other strands. Furthermore, environmental issues often provide the subject matter for work in other curricular areas. Participation in An Taisce's Green Schools Programme by many of the schools in the

evaluation would also be expected to increase environmental awareness among pupils and thus support the implementation of this strand.

5.3 Pupils' procedural understanding

The development of pupils' procedural understanding is the focus of the sections of the curriculum entitled *Working scientifically* and *Designing and making*. The development of procedural understanding should be a feature of all science lessons and activities. The evaluation team administered tasks to 1813 pupils in second, fourth and sixth classes.

Table 5.6: Pupil performance on tasks to assess procedural understanding

Class	Curriculum objective	% of pupils who completed tasks successfully
Second class	The child should be enabled to begin to identify one or two variables with guidance from the teacher.	49%
Fourth class	The child should be enabled to design [and] plan…simple investigations The child should be enabled to realise that an experiment is unfair if relevant variables are not controlled	40%
Sixth class	The child should be enabled to design [and] plan…simple investigations The child should be enabled to realise that an experiment is unfair if relevant variables are not controlled	38%
Total		**43%**

Table 5.6 shows the selected curriculum objective that was tested in each class and the percentage of pupils who were successful in each case. Overall, fewer than half (43%) of the pupils who completed tasks in this area were successful. While the use of tasks to assess the acquisition of skills in this way has its limitations, the evidence suggests that pupil achievement was weaker in this area than in any of the content strands or strand units.

This finding gives cause for concern and should be considered in the context of the findings presented in earlier chapters regarding planning and teaching. The weakest areas of whole-school planning for Science included planning for the use of pupils' ideas and planning for the use of open-ended investigations. Classroom planning for skills development was judged to be poor or fair in approximately half of the classrooms visited. Engagement with pupils' existing ideas was poor or fair in almost half of the lessons observed. Pupils were allowed to devise their own ways of working in less than half of the lessons observed. These findings are similar to those of the NCCA (2008), in which concern was expressed about the infrequency

of ‘child-led’ investigations, the preponderance of teacher-demonstration as a pedagogy and the scarcity of opportunities for pupils to apply certain skills.

The skills sections of the Science curriculum are what make it ‘scientific’. The evidence gathered as part of this evaluation indicates that many pupils had not been given the opportunity to work scientifically, or to develop the procedural skills and understanding that are at the heart of the curriculum.

5.4 Key findings and recommendations regarding quality of learning

5.4.1 Key findings regarding quality of learning

This chapter has presented the findings of the tasks that were administered to assess pupils’ conceptual understanding and procedural understanding respectively. While acknowledging the limitations associated with the tasks that were devised for this evaluation, the outcomes of the tasks provide an indication of pupils’ progress in relation to the various curriculum objectives. The findings indicate that pupil achievement was better in the content strands *Materials* and *Environmental awareness and care than in* the strands *Energy and forces* and *Living things.* The data suggest that, across all four content strands, pupil achievement was highest in the strand units *Caring for my locality*, *Properties and characteristics of materials*, *Myself/Human life* and *Heat*. The strand units in which pupil achievement appeared to be weakest were *Plant and animal life, Sound*, *Light* and *Forces*. Overall, however, the tasks in which pupils appeared to be least successful were those that tested their procedural understanding. Fewer than half (43%) of all pupils tested were successful in these tasks.

In order to bring about improvement, it will be necessary to address issues regarding planning and teaching that were identified and discussed in Chapters 3 and 4. On the basis of the data presented and discussed in this chapter, it is clear that work remains to be done in the following areas.

- The development of procedural skills and understanding, which is required for pupils to work scientifically, needs to be further developed.
- The data on pupil achievement in *Energy and forces* lends further weight to the concerns expressed in the *Report of the Task Force on the Physical Sciences* (Department of Education and Science, 2002a). This is the strand in which pupil achievement appeared to be lowest overall. There is a need for professional development opportunities for all teachers, focusing specifically on this strand.
- Pupils’ understanding of *Plant and animal life* tended to be weaker than their understanding of concepts in any other strand or strand unit. There is a need for schools and teachers to direct fresh attention to this area. There is a need to recognise clearly that the traditional ‘nature study’ approach does not fulfil the requirements of the 1999 curriculum.

5.4.2 Recommendations regarding quality of learning

Procedural skills and understanding

- Schools should review their whole-school planning for *Working scientifically* and *Designing and making* and monitor pupil achievement in these areas.
- Teachers should ensure that they are familiar with the *Working scientifically* and *Designing and making* objectives for their class level and implement programmes that enable their pupils to achieve these objectives.
- Teachers in the middle and senior classes should enable pupils to design and conduct their own investigations and to complete open-ended problem-solving tasks in *Designing and making*.

Energy and forces

- Consideration should be given to providing further professional development for primary teachers in the area of the physical sciences. This would have the dual purpose of improving the teachers' own conceptual understanding as well as their ability to provide effective learning opportunities in the strand *Energy and forces*.

Plant and animal life

- Schools and teachers should ensure that they are familiar with the curriculum objectives for the strand *Plant and animal life* and the approaches to this strand unit that are outlined in *Primary School Curriculum, SESE: Science - Teacher Guidelines*.
- In particular, school grounds should be developed and used as a resource to support the learning of simple ecological concepts and the skills required to use and make identification keys.

Assessment

- It is worth re-stating the point made in Chapter 4 of this report that the availability and use of good assessment materials, specific to the context of the Irish *Primary School Curriculum*, would assist in promoting better teaching of science skills and concepts.

Chapter 6
Main findings and recommendations

6.1 Main findings of the evaluation

6.1.1 Findings of good practice

The findings of this focused evaluation contain much that is encouraging with regard to the teaching and learning of Science in Irish primary schools. At the time of the evaluation, this was a new subject for most Irish primary teachers and there is no recent tradition of science teaching in Irish primary schools.

Whole-school planning

The evaluation found that whole-school planning for Science generally involved extensive collaboration between teachers. Almost all of the school plans that were examined reflected the structure and language of the science curriculum and restated the key principles of the curriculum. There was effective planning at classroom level for integration of Science with other subjects. Most schools had availed of the advice provided by the support services.

Linking Science to the wider environment

Many schools were involved in projects and initiatives that support the objectives of the science curriculum. Some of these projects involved collaboration between the school and local industry. There was evidence that this work had enhanced and enriched the schools' science programmes.

Management of resources

While the practical nature of Science and its links with the other SESE subjects can present challenges for the management of time and other resources, schools and teachers were generally found to be very successful in providing and managing the time, equipment and materials that are necessary for the implementation of the curriculum. The majority of schools had also invited people with expertise in particular areas of Science to work with teachers and pupils.

Teaching and learning

In a majority of the lessons seen, the teachers demonstrated a good or very good understanding of the particular concepts they were teaching. The inspectors reported very positively on teachers' communication skills and their expertise in classroom and lesson management. Most teachers were considered to be good or very good at relating Science to everyday situations that had relevance for pupils. The lessons observed were generally well structured and interesting. Pupils were engaged in hands-on practical tasks and there was a high level of participation by both girls and boys. Most teachers employed a variety of methodologies, including group work, during the lesson. There was an appropriate emphasis on developing the pupils' science vocabulary in most of the lessons seen.

Success in the implementation of strands and strand units of the curriculum

The evaluation found that *Materials* and *Environmental awareness and care* were the content strands in which pupil achievement was best. Across all four content strands, the strand units in which pupil achievement was highest were *Caring for my locality*, *Properties and characteristics of materials*, *Myself/Human life* and *Heat*.

6.1.2 Concerns identified

The findings indicate that, in order to build on these strengths and continue to improve the quality of learning and teaching in Science, schools and teachers need to give greater consideration to the following areas.

Pupil achievement

The short-term planning examined by inspectors in over two-fifths of classrooms did not contain specific learning objectives. As well as leading to less focused teaching, the absence of clear learning objectives meant that there was no basis for assessment at the end of the unit of work. This weakness was associated in many cases with an over-reliance on pupils' textbooks to guide teachers' planning. It was also considered by inspectors to be an impediment to provision for individual pupils with different needs.

The data from pupil-assessment tasks indicate that pupils' understanding of *Plant and animal life* was weaker than their understanding of concepts in any other strand or strand unit. It is important to recognise that the traditional 'nature study' approach does not fulfil the requirements of the *Primary School Curriculum*. The data on pupil achievement in *Energy and forces,* especially *Sound, Light* and *Forces,* suggests that there is a need for professional development that focuses specifically on this strand.

Developing skills

The balance between knowledge and skills is a key learning principle of the curriculum. While many of the school plans restated the objectives of *Working scientifically* and *Designing and making*, they rarely indicated what steps the school would take to support and monitor the development of procedural understanding and skills. At classroom level, planning for skills development was fair or poor in approximately half of classrooms. Interviews with teachers, principals and science co-ordinators indicated that *Designing and making* was often neglected. One third of teachers reported that they seldom or never provided activities in *Designing and making*.

The teaching approaches being used in many of the lessons observed were not conducive to skills development. Pupils' procedural understanding was found to be weaker than their conceptual understanding. There is a need for a much more deliberate emphasis on skills development in planning and teaching if pupils are to develop the ability to work scientifically or to engage in the problem-solving process that is central to *Designing and making*.

Whole-school planning for Science

The link between the school plan and the practical business of teaching and learning needs to be emphasised further. In many cases, school plans were not sufficiently specific

to the context of the individual school to be useful. Many plans did not make any reference to the school's immediate environment or outline how various initiatives in which the school was involved supported the achievement of curriculum objectives.

The potential of the whole-school plan to make sustainable improvements to teaching and learning in the school was rarely realised. Very few school plans provided practical guidance for teachers regarding the implementation of key aspects of the curriculum such as starting with children's ideas, promoting open-ended investigations and fostering problem-solving and other higher-order thinking skills.

6.2 Main recommendations

As a result of this evaluation, the following key recommendations are made with a view to supporting and improving the teaching and learning of Science in Irish primary schools.

6.2.1 Pupil achievement

Recommendations for schools and teachers

- Teachers should base their science programmes and lessons on curriculum objectives and the needs of pupils, rather than the content of any single pupils' textbook. Textbooks may be used, as relevant, to support the achievement of learning targets that are in accordance with curriculum objectives and identified pupil needs.
- Classroom planning should identify clearly the intended learning outcomes to be achieved and monthly progress records should provide details of the learning that has taken place.
- Schools should assess pupil achievement in Science regularly and the results of assessment should be used to inform subsequent planning and teaching.
- Teachers should elicit and record pupils' existing ideas as a starting point for all science activities. The information gathered should provide a basis for teacher-pupil interactions during the lesson and for review and assessment at the end of the unit of work.
- Samples of pupils' observations, concept maps, drawings etc should be displayed in classrooms and used to monitor the development of understanding. Useful advice in this regard may be found in *Primary School Curriculum, SESE: Science - Teacher Guidelines* (Department of Education and Science, 1999b, pp. 142 – 145).
- Schools and teachers should ensure that they are familiar with the curriculum objectives for the strand *Plant and animal life* and the approaches to this strand unit that are outlined in *Primary School Curriculum, SESE: Science - Teacher Guidelines* (Department of Education and Science, 1999b).
- School grounds should be developed and used as a resource to support the learning of simple ecological concepts and the skills required to use and make identification keys.
- Teachers' classroom planning for Science should always indicate how teaching will be differentiated for pupils with particular individual needs. Schools will find

Guidelines for Teachers of Students with General Learning Disabilities (NCCA, 2007) useful in implementing this recommendation.

- Schools should ensure that all teachers are familiar with *Assessment in the Primary School: Guidelines for Schools* (NCCA, 2007).

Recommendations for others

- The development of a range of effective assessment materials, specific to the context of the Irish *Primary School Curriculum* would support improvement in teaching and learning in Science. The Department should consider ways in which the development of such materials might be supported or encouraged.
- The Department should give consideration to providing for further focused professional development for primary teachers in the area of the physical sciences.

6.2.2 The skills sections of the curriculum

Recommendations for schools and teachers

- Teachers should ensure that they are familiar with the *Working scientifically* and *Designing and making* objectives for their class level and implement programmes that enable their pupils to achieve these objectives.
- Teachers in the middle and senior classes should enable pupils to design and conduct their own investigations and to complete open-ended problem-solving tasks in *Designing and making*.

Recommendations for others

- All initial teacher-education programmes should include a practical workshop-based component to develop students' understanding of scientific concepts and their knowledge and skills in the area of Science education..
- Supporting teachers and schools in the development of pupils' procedural skills and knowledge should be a priority in the work of the support services and in the provision of online resources for Science.

6.2.3 Whole-school planning for Science

Recommendations for schools and teachers

- Designating a teacher to provide effective curriculum leadership in Science at school level can have a very beneficial effect on the quality of school planning and curriculum implementation in the subject. Schools should consider designating a teacher as a Science co-ordinator for this purpose.
- The role of science co-ordinator in schools should include responsibility for developing and monitoring the implementation of the school plan for science, co-ordinating the development and use of the school grounds and co-ordinating the professional development of the staff.
- Schools should ensure that the whole-school plan for Science records accurately the good practice that has been developed in response to the particular needs of that school and the resources available locally.
- In particular, all whole-school plans for Science should include strategies that teachers will use to elicit and record pupils' ideas and to enable pupils to undertake open-ended investigations.

- Activities in the local environment and participation in projects such as the Green Schools initiative provide an opportunity for the development and reinforcement of scientific and technological skills and concepts. They should be recognised as such in the school plan and should be linked clearly with particular curriculum objectives.
- Schools should review their whole-school planning for *Working scientifically* and *Designing and making* and monitor pupil achievement in these areas.

References

Department of Education and Science (1999a). *Primary School Curriculum: Science.* Dublin: Stationery Office.

Department of Education and Science (1999b). *Primary School Curriculum: Science: Teacher Guidelines.* Dublin: Stationery Office

Department of Education and Science (2002a). *Task Force on the Physical Sciences Report and Recommendations.* Dublin: Stationery Office.

Department of Education and Science (2002b). *Fifty School Reports: What Inspectors Say.* Dublin: Stationery Office.

Department of Education and Science (2005a). *An Evaluation of Curriculum Implementation in Primary Schools: English, Mathematics and Visual Arts.* Dublin: Stationery Office

Department of Education and Science (2005b). *Literacy and Numeracy in Disadvantaged Schools: Challenges for Teachers and Learners.* Dublin: Stationery Office

Department of Education and Science: Inspectorate (2007) *Irish in the Primary School.* Dublin: Stationery Office.

National Council for Curriculum and Assessment (2007a). *Assessment in the Primary School Curriculum: Guidelines for Schools.* Dublin: NCCA

National Council for Curriculum and Assessment (2007b) *Guidelines for Teachers of Students with General Learning Disabilities.* Dublin: NCCA

The Teaching Council (2011) *Initial Teacher Education: Criteria and Guidelines for Programme Providers.* Maynooth: The Teaching Council