The Education and Training Inspectorate

Providing Inspection Services for

Department of Education
Department of Higher and Further Education, Training and Employment
Department of Culture, Arts and Leisure

INVESTOR IN PEOPLE

The Education Reform Programme

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

Survey of Science

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

and Technology

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

and Design

(1999-2000)

CONTENTS

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

FOREWORD

Introduced in 1990, Education Reform (ER) in Northern Ireland (NI) had as its central aim the raising of standards in education at every level. In support of this aim within the science and technology area of study, the Department of Education (DE) will have allocated by March 2001, through the Education Reform Programme (ERP), some £167m, mainly towards the provision and refurbishment of science and technology and design facilities in post-primary schools, and the provision of sinks, power-points and storage in primary schools. Following the introduction of ER, the Curriculum Advisory and Support Service (CASS) of each of the five Education and Library Boards (ELBs) in NI has provided a range of specialist support, including in-service training (INSET) courses to enable teachers of science and of technology and design to deliver the related programmes of study within the Northern Ireland Curriculum (NIC). The significant additional funding made available through the ERP, coupled with the work of CASS, has facilitated the implementation of the NIC in science, and technology and design, in post-primary schools in NI.

Almost all of the £167m has been allocated to science, and to technology and design, in post-primary schools, with only a small percentage of the monies allocated to the provision of information technology (IT)[1] facilities in the post-primary phase. By March 2000, 239 new science laboratories had been provided and a further 439 refurbished; by the same date, 337 new rooms for technology and design had also been provided and a further 373 refurbished.

---

1 Within the body of the report, IT will be referred to by the more recent terminology, namely information and communications technology (ICT).

Given the significant expenditure and improved provision outlined above, the survey focused on the impact of the ERP on science, and technology and design, in post-primary schools in NI. The main aims of the survey were:

- to evaluate the impact of the ERP spending in relation to (i) learning and teaching in science, and in technology and design, and (ii) the standards achieved by the pupils within and across the area of study;

- to establish the quality of provision in science, and in technology and design, compared with the findings reported in 1990[2] and 1994[3]; and

- to obtain evidence in order to inform decisions regarding the need to continue the ERP for science, and technology and design.

The findings of the survey are based mainly on evidence gained from the 379 science lessons, and 384 technology and design lessons, observed in the 25 post-primary schools which were visited as part of the survey[4]; unless otherwise stated, the percentage figures used throughout the report are based on the findings in these schools. The trends that emerged from this sample are in line with the findings of specialist inspectors of science, and of technology and design, in the normal course of their specialist inspection work, undertaken since the publication of the last composite report on science, and technology and design, in 1994.

The survey report is intended to help departments of science, and of technology and design, CASS and the DE to identify and implement the priorities for action over the next few years.

---

2 Secondary Education 1990: A Report by the Inspectorate.

3 Secondary Education 1994 : Science and Technology: A Report by the Inspectorate.

4 The survey visits in two of these schools were undertaken as part of general inspections at the schools - see Appendix.

1. INTRODUCTION

1.1 In early January 1999, the principals of the 237 post-primary schools in NI were asked by the Inspectorate to have a questionnaire completed by the head of science, and by the head of technology and design, and to return the questionnaire to the DE for analysis. A return rate of 100% was recorded and the Education and Training Inspectorate (Inspectorate) values the diligence and helpfulness of the schools in returning the completed questionnaires.

1.2 On the basis of the returns, a valuable database of important background information for the survey was established. Furthermore, in conjunction with other information, the returns enabled a sample of 25 post-primary schools of varied size and type across NI to be identified for subsequent visits in connection with the survey. Almost all of the schools were visited jointly by a specialist inspector of science and a specialist inspector of technology and design. Seven of the schools were visited during the period February 1999 to May 1999, with the remaining visits taking place during the first term of the 1999-2000 academic year. For the purpose of the survey, classroom visits were restricted to key stages 3 and 4; for those schools visited from September 1999, one of the inspectors also discussed, generally with the principal, each school's arrangements for Child Protection. All of these schools were making progress, to varying degrees, in meeting the requirements for Child Protection set out in DE Circular 1999/10 'Pastoral Care in Schools: Child Protection'.

1.3 At the end of each survey visit, an oral report of the main findings, in relation to the work in science, was given to the head of science along with the school principal; similar provision was made to report the main findings in technology and design.

1.4 In mid June 1999, the Chief Executives of the five local ELBs were asked by the Inspectorate to agree to the involvement of some of their officers in meetings with the reporting inspector and his specialist colleague for technology and design. The main purpose of the meetings was to consider the officers' views regarding the developments in science, and in technology and design, as a result of the ERP. In December 1999, five separate meetings with the Inspectorate were held, one for each of the five ELBs, and involved a Senior Education Officer and the Adviser(s) for science and technology and design. These meetings provided a useful forum for the exchange of information and insights into the general outworkings of the ERP in science and technology and design. The main outcomes of the meetings are included later in Section 4 of the report.

1.5 The framework of the NIC was introduced in 1990 with the objective of ensuring breadth and balance in the curriculum of all young people. 'Secondary Education 1990, A Report by the Inspectorate' had indicated a number of concerns regarding the breadth and balance of the pupils' experiences, some of which related directly to science, and to technology and design. For example, while all pupils studied science in years 8 to 10, and most followed a broad and balanced science programme, only a minority continued with a broad and balanced science programme in years 11 and 12, and a minority of pupils discontinued their study of science at the end of year 10. In general, the pupils who studied all three sciences in years 11 and 12 tended to be in selective schools, where they studied biology, chemistry and physics separately to GCSE level. While the science programme provided for these pupils was broad and balanced, it occupied approximately a third of their curricular time. Most pupils in selective schools, however, did not follow a balanced science programme; the girls tended to study biology, whereas boys tended to take chemistry and/or physics. In general, science was the prerogative of the abler pupils, and technological learning was absent from the curriculum of most pupils.

1.6 'Secondary Education 1994: Science and Technology: A Report by the Inspectorate' pointed to the fact that the evidence from inspection indicated that more and more schools were gaining in confidence and commitment to the NIC, and to the growing extent to which the curriculum in schools in years 8 to 12 had become broad and balanced. Science, and technology and design, for example, were now compulsory elements of the curriculum for all pupils in key stage 3 (KS3). At KS4, the minimum requirements for the science and technology area of study were the reduced programme of study for science, leading to a single award GCSE, and a short course in technology and design. It was anticipated, however, that the majority of pupils would follow the full programme of study for science in the NIC leading to a double award GCSE. Currently, while the minimum requirement for science at KS4 remains unchanged, the minimum requirement for technology and design has been removed. Nonetheless, the uptake of the subject at KS4, particularly in recent years, has shown a significant upward trend. In general, the teachers of science, and of technology and design, have worked hard to implement the associated programmes of study in the NIC.

1.7 In evaluating the various features of provision, including the quality of leadership, inspectors relate their judgements to four performance levels which may be interpreted as follows:

Grade

1	Significant Strengths	good (ranging to outstanding)
2	Strengths outweigh any weaknesses	satisfactory (ranging to good)
3	Weaknesses outweigh strengths	fair (ranging to satisfactory)
4	Significant Weaknesses	poor

A number of quantitative terms are used throughout the report to present the findings. These terms should be interpreted as follows:

almost/nearly all	-	more than 90%
most	-	75%-90%
a majority	-	50% - 74%
a significant minority	-	30% - 49%
a minority	-	10%-29%
very few/ a small number	-	less than 10%

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

2. SCIENCE

2.1 Ethos

2.1.1 Almost all of the teachers of science set and maintain a suitable climate for learning; they foster good to excellent relationships with their pupils, and lessons are conducted in an atmosphere conducive to learning. Most of the teachers also take a pride in the resources available to them and ensure that the resources are well maintained and used appropriately. Furthermore, a majority create an interesting and stimulating environment which promotes a good science ethos and contributes to learning and teaching. In a significant minority of instances both within and amongst schools, there is considerable scope to improve the visual appeal of the science laboratories, through, for example, the thoughtful use of photographs, commercial posters and live plants, and the display of samples of the pupils' recent and current work.

2.2 Planning

2.2.1 Most teachers of science reflect in their written planning the requirements of the NIC for science and show a commitment to implementing the departmental schemes of work. While most of the schemes of work are detailed and comprehensive, in relation to content, resources and activities, especially at KS3, only a small number make appropriate reference to the intended learning outcomes. In addition, while almost all science teachers place an appropriate emphasis in their planning on the attainment targets of Living Organisms and Life Processes, Materials and their Uses, and Physical Processes, in a majority of cases the planning for attainment target (AT) 1 - Experimental and Investigative Science - is inadequate.

2.2.2 When planning their lessons and topics, approximately one half of science teachers take satisfactory to good account of the ability and interests of individual pupils. In the remainder of instances, the weaknesses outweigh strengths in this important consideration. In most of the schools visited, there were significant weaknesses, or weaknesses outweighed strengths, in the teachers' planning for collaboration within and beyond the science and technology area of study. Only in a small number of instances was there adequate planning to guide curricular collaboration between the teachers of science and the teachers of technology and design. There was an equal shortfall in the extent of planning to guide curricular collaboration between the teachers of science in post-primary schools and their counterparts in the contributory primary schools.

2.3 Learning and Teaching

2.3.1 Almost all of the teachers of science are hardworking and conscientious; they are keen to provide the best for their pupils and to support them in their work. In most instances, the teachers of science make satisfactory to good use of the accommodation available to them, including, where relevant, the improved range of facilities made possible through the ERP.

2.3.2 The quality of teaching seen during the survey visits ranged from unsatisfactory, in four instances, to outstandingly good. Table 1 below sets out the number of lessons seen along with the grades awarded and the grade descriptors. Of the 379 science lessons observed, 18% had significant strengths while in a further 50%, the strengths outweighed the weaknesses. The lessons in these categories were conducted at a good pace, the pupils spoke with confidence and interest about science, and generally achieved good standards in their work. In a lesson graded 1, for example, a year 9 science class explored the concept of Force. The pupils had good opportunities to discuss their understanding of Force with their peers and with the teacher, and a range of interesting practical tasks caught their interest and imagination and supported their learning. By the end of the lesson the pupils had deduced that forces can change the shape of objects, that they can cause and prevent motion and can change the direction in which a body is moving. In another science lesson, also graded 1, a group of less able year 12 pupils considered the relationship between exercise and increased pulse rate. The teacher's approach was patient and supportive; the pupils enjoyed the range of practical tasks organised by the teacher, and the work and associated discussions helped develop their understanding in science, along with their science vocabularies and their use of language generally.

2.3.3 In 27% of the lessons seen, the weaknesses outweighed the strengths, while in a further 5% there were significant weaknesses. In the lessons in these categories, the pupils' learning was adversely affected and the standards they achieved were not good enough; the teaching did little to stimulate the pupils' interest in science. The pupils were often required to copy an excessive amount of notes from, for example, their textbooks, and they had too few opportunities for practical work or to develop their oral skills through purposeful discussion; many of these pupils associate science with sitting and writing rather than thinking, talking and doing. In a lesson graded 3, for instance, a year 9 science class dealt with the circulation of blood in the human body. The pupils played a mainly passive role in the lesson and had few opportunities to explore and develop their thinking in science through talking and listening with their peers. A video used to illustrate blood flow in the human body was too sophisticated and served only to confuse rather than help the pupils with their learning. In a lesson graded 4, the Kinetic Theory was the topic for a year 12 chemistry class: the teacher's control of the class was largely ineffective; the pupils were allowed to be noisy and inattentive and, consequently, their learning was impeded. Furthermore, the pupils engaged in an excessive amount of copywriting from their text books, and the teacher's questioning of the pupils failed to test adequately their understanding in chemistry, or to challenge their thinking in the subject.

Table 1: Lessons seen with grades and grade descriptors

Lessons Seen	Percentage of Total	Grade Awarded	Grade Descriptor
68	18%	1	significant strengths
190	50%	2	strengths>weaknesses
104	27%	3	weaknesses>strengths
17	5%	4	significant weaknesses

2.3.4 On the evidence of the lessons seen, the most effective teaching of science was typified by a range of factors, including the following:

- thorough preparation and realistically high expectations;
- clearly identified learning outcomes and the use of a variety of learning and teaching approaches;
- the relevance of science to everyday life explored and explained;
- good use of ICT, overhead projectors and three-dimensional science models to enliven lesson presentation and aid learning;
- enjoyment and good teacher-pupil relationships;
- good opportunities for the pupils to engage in discussion; and to record their observations in science in their own words.
- challenging tasks, matched well to the pupils' needs and abilities;
- good balance between practical and theoretical work; and
- careful consolidation of the pupils' learning at the end of the lesson.

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

The least effective teaching of science was typified by a combination of some of the following factors:

- the nature and purpose of the lesson was not made clear to the pupils;
- the teacher's questioning of the pupils lacked rigour;
- the use of poor quality worksheets;
- too few opportunities for talking and listening;
- excessive copywriting and insufficient practical work;
- strained pupil-teacher relationships and ineffective control of the class; and
- poor management of time.

2.3.5 A majority of science teachers use a range of learning and teaching strategies including whole-class teaching, group, paired and individual work, achieve an appropriate balance between practical and theoretical work and have realistically high expectations of the standards the pupils can achieve. The remainder of science teachers have shortcomings in some or all of these important areas in their work. A similar pattern is evident in relation to how effective the teachers of science are in setting motivating, challenging and interesting tasks in science and, in particular, in meeting the needs of all of the pupils in their science classes. Only a minority of science teachers take sufficient time to monitor and review the effectiveness of their work.

2.4 The Range and Quality of the Pupils' Experiences

2.4.1 In general, the improved facilities for science, provided through the ERP, have enhanced to varying degrees, within and between schools, the range and quality of the pupils' experiences in the subject.

2.4.2 A majority of the pupils in years 8 to 12 display a good knowledge and understanding of, and interest in, science; a minority, however, see no relevance in the work they do in the subject. For some, this is the result of weaknesses in how they are taught; others, however, see little of intrinsic value in science and their interest in the subject is thereby diminished.

2.4.3 A majority of pupils achieve satisfactory to good standards in science in school and public examinations, a significant minority, however, do not. In one selective school, for example, where the majority of year 12 pupils are entered for GCSE Science: Single Award, the school's results over the last three years at Grades A* to C in this examination have been some 16% below the NI average for schools of a similar type. In one of the non-selective schools surveyed, the results in GCSE Science: Double Award over the last three years have been some 24% below the NI average for Grades A* to E for schools of a similar type.

2.4.4 When afforded the opportunity, most pupils can choose and handle scientific equipment with confidence, competence and due regard for safety, and, when working in groups they do so effectively. Just over one half of pupils can successfully plan and carry out investigations in a logical manner and make informed observations. In most instances, the pupils' shortcomings in these important scientific skills are linked directly to the too low profile afforded by their teachers to the implementation of AT1, namely, Experimental and Investigative Science. Other significant weaknesses in the pupils' work include their general inability to formulate hypotheses, to apply scientific knowledge in unfamiliar contexts and to evaluate scientific evidence objectively; only a minority of pupils achieve success in these important aspects of learning in science.

2.4.5 A majority of pupils have good science vocabularies and communicate effectively in a variety of ways; an almost equal number have shortcomings in these respects. A significant minority record their work in different ways, including their own words, charts, diagrams and graphs; most of the pupils produce written work which is neat, legible and kept up-to-date. In general, however, the pupils have too few opportunities to record their thinking, observations and findings in science by expressing their ideas in writing using their own words. Furthermore, just over one-third can apply their understanding in science to moral, social, economic and environmental issues.

2.4.6 In the schools surveyed, only a small number of pupils in science used a range of information resources, including ICT and the school library, confidently and competently. In general, the work in science currently makes too little contribution to the pupils' learning in literacy and ICT. In addition, the potential of science as a meaningful context for developing the pupils' skills in numeracy is largely underdeveloped. The general lack of curricular collaboration between the teachers of science in post-primary schools and their counterparts in the contributory primary schools leads to discontinuity in the pupils' learning in science across the KS 2/3 interface. A similar lack of collaboration between science and technology and design departments, limits the coherence of the pupils' learning across the area of study.

2.4.7 Almost all pupils follow a broad and balanced science programme at KS3. At KS4, however, while almost all continue to follow a balanced programme, a significant minority follow a science programme which lacks sufficient breadth. In general, those in non-selective schools choose between a reduced programme of study for science at KS4, leading to the GCSE Science: Single Award (SA), and the full programme of study leading to a GCSE Science: Double Award (DA). On the other hand, the pupils in selective schools choose between GCSE Science: Double Award, and the separate study of biology, chemistry and physics to GCSE level, sometimes referred to as the Triple Award (TA) option. A small number of pupils, all of them from non-selective schools, follow a non-GCSE science course at KS4.

2.4.8 On the basis of figures provided by the NI Council for the Curriculum, Examinations and Assessment (CCEA) for the Summer of 1999, 38% of the year 12 candidates were entered for the GCSE Science: SA courses (modular or non-modular), 49% for GCSE Science: DA courses (modular or non-modular) and 13% for separate GCSE courses in biology, chemistry and physics. Of those involved in the SA courses, almost all were from non-selective schools and, of these, some 95% were following the modular ie limited grade route. Of the candidates following the GCSE Science: DA courses, a majority were from selective schools; of those following the TA route, some 95% were also from selective schools. Table 2 illustrates the range of uptake of GCSE and non-GCSE science courses in the schools visited as part of the survey.

Table 2: Range of Uptake of GCSE and non-GCSE science courses in the schools visited*

Course Title	Percentage Uptake by Pupils at KS4
SA (modular) ^	zero (eleven schools) to almost 77% (one school)
SA (non-modular)	zero (eleven schools) to 77% (one school)
DA (modular or non-modular)	14% (one school) to 100% (one school)
GCSE TA	zero (fifteen schools) to 42% (one school)

* Excluding the Junior High Schools.

^ The maximum grade achievable in this course is a Grade C; the remaining GCSE courses attract the full range of grades.

2.4.9 The amount of curriculum time allocated to science at KS3 varies from school to school. In the schools visited, the average time allocated to science at KS3 was c350hrs. However, the range of time varied from some 214.5 hours in one school to 432.25 hours in another, a difference of 217.5 hours of teaching time for science over the key stage.

2.4.10 Given the time differences, some teachers of science are better placed than others to implement the content and skills of the programme of study for science at KS3.

2.4.11 The amount of curriculum time allocated to the various science courses at KS4 also varies in general from school to school and, as Table 3 illustrates, there are significant differences in the times involved. Once again, given the time differences, some teachers are, potentially, better placed than others to cover the science content and skills required by the various science courses at KS4.

Table 3: Average times in hours allocated to science at KS4.

Course	Av time (hrs)	lower limit (hrs)	upper limit (hrs)	Difference over the KS (hrs)
SA modular *	250	182	312	130
SA non-modular	236	195	273	78
DAS	445	331.5	591.5	260
TA	620.6	546	682.5	136.5
Non-GCSE	239.5	136.5	292.5	156

* The maximum grade achievable in this course is a Grade C; the remaining GCSE courses attract the full range of grades.

2.4.12 As indicated in paragraph 2.4.7, a significant minority of pupils at KS4 follow a science programme which lacks sufficient breadth; in short, too many of the pupils at KS4 in NI are following a SA science course and too few are following a DA science course. Those who embark on single award and non-GCSE science courses, limit significantly their opportunities for further studies in science beyond KS4, a fact which may ultimately affect adversely their employment prospects in careers in science, engineering and technology. Furthermore, if the trend is not reversed, it may lead to a situation whereby the limited availability of young people in NI, well-grounded and qualified in science, will deter potential inward investment by employers needing a scientifically skilled workforce. On the basis of figures provided by the NI Council for Curriculum, Examinations and Assessment, (CCEA) the uptake of GSCE Science: SA courses has increased from some 34% of year 12 pupils in 1995 to some 38% in 1999. Over the same period of time, the uptake of GCSE Science: DA courses has declined from some

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

53% in 1995 to around 49% in 1999. These figures fall short of DE's aspiration, in the early years of ER, that the majority of pupils at KS4 would follow the full programme of study for science leading to a double award GCSE. Over the last five years, the uptake by year 12 pupils of the TA option, ie the study of separate GCSE courses in biology, chemistry and physics, has remained steady at around 13%. Of those year 12 pupils following the GCSE Science: SA route over the last five years, typically 85% have followed the modular ie the limited grade course. On the evidence of inspection, a significant minority of these pupils, along with those following a SA non-modular science course, could cope readily with the demands of a GCSE double award science qualification. Table 4 shows the number of year 12 pupils entered for GCSE and non-GCSE courses in the schools visited as part of the survey.

Table 4: Showing the number of year 12 pupils in the schools visited entered for GCSE and non-GCSE examinations

Course	Number of Year 12 pupils	Percentage of the Total No of Pupils
Science SA modular*	577	25%
Science SA non-modular	302	13%
DAS	1182	51%
TAS	197	8%
Non-GCSE	74	3%
Total	2332	100%

* The maximum grade achievable in this course is a Grade C; the remaining GCSE courses attract the full range of grades.

2.4.13 Of the year 12 pupils referred to in Table 4, some 70% were entered for qualifications offered by CCEA; the remainder were entered for qualifications offered by other Awarding Bodies. In the schools visited as part of the survey, the number of candidates entered for GCSE/non-GCSE science qualifications offered by CCEA, varied from zero in four of the schools, all of them non-selective, to 100% in eleven of the other schools, the majority of which (72%) were selective schools.

2.4.14 Key stage assessment became a statutory requirement in NI in 1996/97. Table 5 below shows the performance of pupils in the KS3 tests in science and, for the purpose of comparison, mathematics. The table also includes the targets set by the Government for attainment in mathematics for 2002 at this key stage. As yet, no equivalent targets have been set for science.

Table 5

	1996/97	1997/98	1998/99	Target 2002
	% Achieving	% Achieving	% Achieving	
Key Stage Three	Level 5 or above			
Mathematics	72.7	66.2	70.1	85.0
Science	59.4	67.0	65.2	No Target
	Level 6 or above			
Mathematics	49.8	44.5	45.9	55.0
Science	34.6	40.1	39.1	No Target

2.4.15 The key stage assessments have only been in operation for the last three years, and, in 1996/97, as a result of concerns expressed by the Teachers' Unions, they were not applied in all primary and post-primary schools in NI. It is, therefore, too early to discern trends in the performance in science in relation to the various levels, other than to say that the pupils' achievements in science at the end of KS3 have been uneven over the last three years.

2.4.16 With the exception of GCSE Science: SA (modular and non-modular), where the performance of candidates over the last five years has been uneven, figures provided by CCEA indicate that, in general, there has been a sustained trend of improvement in candidates' performance over the last five years in the remaining GCSE science examinations. In GCSE Science:

Biology, for example, the percentage of candidates achieving Grades A* to C has increased from 85.4% in 1995 to 91.0% in 1999. In GCSE Science: DA (modular), the percentage of candidates achieving Grades A* to C has increased from 62.9% in 1995 to 73.9% in 1999, and the percentage of candidates achieving grades A* to E has increased over the same period of time, from 93.7% in 1995 to 97.7% in 1999.

2.4.17 Of the schools surveyed, most indicated that the improvements in the accommodation and resources provided through the ERP had facilitated increased opportunities for the pupils to engage in practical work; a majority also indicated that the improvements had led to a discernible enhancement in the pupils' practical skills in science. A majority of the schools recorded that the ERP monies had led to increased use of ICT by the pupils; however, only a minority said that the improvements in accommodation and resources had enabled an increased allocation of time to science within the curriculum. Two of the schools indicated that the improvements to their science accommodation through the ERP had eliminated or reduced the incidence of pupils being taught science in general purpose classrooms.

2.4.18 The findings of the survey visits, and those from inspection in science generally, confirm the schools' judgements as set out in paragraph 2.4.17 above. However, in the work of just under one half of science teachers, there is scope for further improvements in the quality of, and time afforded to, practical work by pupils. In addition, only a small number pupils make broad and effective use of ICT to support their learning in science.

2.4.19 In general, the findings of the survey, based on classroom visits and on discussions with pupils and science teachers, indicate that in a majority of schools, where improvements to the accommodation and resources for science have been provided through the ERP, teaching and learning have been enhanced, and the standards achieved by the pupils improved. In a majority of the schools, there has been a significant improvement in relation to the morale of pupils and science teachers alike.

2.5 Management

2.5.1 In the majority of schools, the science department is organised effectively and the science teachers meet regularly and frequently, for example, to plan and organise their schemes of work or to consider the quality and effectiveness of the departmental assessment arrangements; in a small number of schools, the leadership of the head of science is not as effective as it should be.

2.5.2 On the basis of discussions with heads of science, and the scrutiny of departmental documentation, the survey visits have found a number of weaknesses in departmental management, which are evident in the majority of, or most, schools. These weaknesses include the need for teachers of science, under the guidance of the head of department, to meet regularly and frequently to:

- plan for improvement on the basis of the evaluation, and review of current provision, especially the effectiveness of learning and teaching;
- consider the implications of, and opportunities for, pupil self-assessment;
- ensure that the pupils know and understand the standards upon which judgements are made in monitoring and assessing their written and practical work;
- compare and contrast examination results within the subject and across subjects and to set targets for further improvement;
- consider departmental development issues within a whole-school context, taking account of the pupils' general education and the potential contribution of science.

Another issue is the need to develop further the role of heads of science as middle managers, and this has particular relevance to school principals in the broader context of school management as a whole.

2.5.3 In a minority of departments, a good start has been made in preparing departmental development and action plans. In the best examples, the plans have identified appropriate targets and success indicators to measure improvement in learning and teaching as the over-riding concern of the teachers within the science department.

2.5.4 In general, SA GCSE science courses are taught by one science teacher. In DA science courses, both modular and non-modular, the responsibility for teaching the course is, in the main, shared amongst the subject specialist teachers of biology, chemistry and physics. The three separate sciences are invariably taught at GCSE level, by subject specialist teachers of biology, chemistry or physics. In general, these arrangements work to the benefit of the pupils; however, increased communication amongst the teachers of biology, chemistry and physics would help to improve further the pupils' understanding of the links amongst the subjects and enhance the coherence of their learning in science generally. In a small number of schools, communication amongst the teachers of biology, chemistry and physics is impeded by departmental management arrangements which strengthen, rather than diminish, the subject and department demarcations.

2.6 Accommodation and Resources

2.6.1 In the majority of the schools visited, the total number of full-time qualified teachers of science, and the total number of rooms available for the subject, were sufficient to meet current needs; in a similar proportion, good to satisfactory use was being made of the accommodation to promote learning and teaching in science.

2.6.2 In 56% of the schools visited, the accommodation for science was suitable for a range of practical work in the subject; there were, however, shortcomings in this respect in a further 20%, and significant weaknesses in a further 24%. Most of the schools made satisfactory to good use of the science preparation and ancillary stores; in most, too, the equipment and other resources for science were well organised. In almost all of the schools, the management of health and safety issues ranged from satisfactory to good; for example, warning signs were in place as appropriate and the relevant safety literature was easily accessible.

2.6.3 Almost all of the science departments in the schools surveyed had benefited from the ERP funding through the provision of new and/or refurbished laboratories. Deficiencies remain: a minority of the schools still had an insufficient number of specialist rooms for science; a significant minority had too little ancillary space; in a similar percentage, some features of the existing accommodation fell short of the standards and requirements set out in the DE Building Handbook. In three of the schools in the last of these categories, the shortfalls were very significant, and the quality and scope of the pupils' learning in practical work were consequently and significantly impaired. A small number of the schools recorded deficiencies in all three of the aspects outlined above; a significant minority had no such deficiencies.

2.6.4 A majority of the deficiencies outlined in paragraph 2.6.3 will be overcome during the 2000-2001 school year when the DE will be funding, through the ERP, the provision of 12 new laboratories and refurbishment of a further 28. In addition, the Department is aware of the need to refurbish a further 25 laboratories. Nonetheless, shortfalls will still remain and give reason for the Department to continue the ERP in science until all of the shortcomings in science accommodation in post-primary schools are eradicated.

2.6.5 In addition to those mentioned in the preceding paragraph, other shortcomings were noted during the survey. For example, as the result of the use of poor quality furniture and fittings, a small minority of the laboratories refurbished through the ERP are now in poor repair, and will need further refurbishment. Also, since the outset of the ERP, and particularly in the early years of the programme and often in the interests of expediency, a significant minority of undersized science laboratories have been refurbished. Consequently, in line with the Department's Circular 1978/36 Class Sizes in Practical Subjects, these rooms will only accommodate sometimes significantly small numbers of pupils for the purposes of practical work. In a small number of schools, proprietary laboratories were installed using ERP monies. In general, these systems have several shortcomings, including important health and safety deficiencies, and most of them will need to be replaced. In addition to adding weight to the argument to continue the ERP for a number of years to come, these shortcomings also point to the need for the DE to ensure that appropriate quality control measures are agreed, and applied consistently across all schools irrespective of school management type. In particular, the measures should seek to make certain that the specifications and layout drawings comply fully with the Building Handbook requirements in respect of both laboratories and the associated preparation/ancillary rooms.

2.6.6 As mentioned earlier in paragraph 2.4.6, work in science currently makes too little contribution to the pupils' learning in ICT. This is linked, in part, to the sometimes limited computer hardware and software resources within science departments; up to about one half, for example, do not have the basic level of provision of two computer systems per laboratory as recommended by the DE in January 1998. Within the context of the continuing need to review and update the Building Handbook specifications and requirements for science accommodation, there is a pressing need to decide the best way to facilitate the use of computers within a science laboratory.

2.6.7 The quality of technical support for science is satisfactory or better in almost all schools; the level of such support, however, is only appropriate in a minority of schools. In those schools visited as part of the survey, the level of technical support ranged from zero hours per week (in three schools) to in excess of 40 hours per week in five others. In those schools with no or inadequate levels of technical support, a significant extra burden is placed on the teachers of science in preparing equipment and materials for use by pupils in practical work.

3. TECHNOLOGY AND DESIGN

3.1 Ethos

3.1.1 The majority of teachers of technology and design have a strong sense of loyalty to their school; relationships amongst them are good, they work well together at departmental level and, for the most part, they contribute to the development of the subject in a constructively self-critical manner. Most teachers of the subject set and maintain a suitable climate for learning, consistent with the departmental ethos and aims; they participate willingly in preparing schemes of work and in the production of associated support materials. The majority of teachers of technology and design take a pride in the resources for which they have specific responsibility to ensure that they are well maintained and used appropriately.

3.1.2 The majority of teachers of technology and design also establish good relationships with their pupils. In turn, the pupils are well motivated, particularly when using machinery, tools and materials to create technological products, and these are valued by their peers and parents alike. In addition, the pupils achieve realistically high levels of success and are encouraged by their teachers in their efforts and expectations. In a minority of schools, the pupils show a particularly strong sense of attachment to the technology and design department; for example, many continue their project work after school hours and, at KS4, they often work with their teachers over school holiday periods.

3.1.3 A small number of technology and design departments have established strong links with local businesses, industry and institutes of further and higher education. These links have been mutually beneficial, particularly in raising the esteem of the teachers concerned and contributing to the building of a team spirit between the schools and others who can support its work. In most cases, the KS4 pupils have benefited from the support and guidance of professional engineers and craftspeople and, in some cases, the school has benefited from the provision of additional resources, mostly in the form of materials and equipment.

3.2 Planning

3.2.1 The quality and standards of planning continue to improve as the teachers become more confident in their understanding of the subject requirements. A minority of schools take sufficient account in their planning of the four subject elements - designing, communicating, manufacturing, and using energy and control. In a few of these schools, the teachers assess the pupils' competence in each of the subject elements and use the findings as a measure of the appropriateness of their planning. In addition, these findings are used to inform further planning for remedial measures for particular pupils and to determine holistically the pupils' technology and design capability. In only two of the schools visited during the survey, did the teachers attempt to cross reference the assessment findings in each of the subject elements with the level descriptions for technology and design; this is a weakness which needs to be addressed. The holistic nature of the subject and the importance in planning for the single attainment target - technology and design capability - have yet to be fully realised in almost all post-primary schools.

3.2.2 The majority of schools do not reflect fully the KS3 requirements of the NIC for technology and design in their long term planning. The teachers acknowledge, and the survey findings confirm, that there is insufficient emphasis placed on the use of metal and on generating, developing and evaluating design proposals. While the balance of work between theory and practice in the majority of schools at KS3 is appropriate, the time available to teach the programme of study, particularly in selective schools, is often significantly less than the 7.5% curriculum time recommended by the CCEA. Consequently, in these circumstances, the pupils' breadth of experiences is limited and their preparation for selecting and progressing to KS4 courses is not as comprehensive as it should be.

3.2.3 Generally, the teachers' individual planning for lessons and topics in technology and design at KS3 is sound in relation to subject content but it does not take sufficient account of the ability, interests, motivation and needs of individual pupils, especially those pupils who require additional help and support. In almost every school surveyed, the pupils in a given year group, irrespective of ability, covered the same units of work, used the same resources and were assessed against a common standard. For example, in one school, all of the pupils in each year group, irrespective of ability, completed two written tests each year: the marks ranged from 85% to 7% with the average across each year group at less then 50%. The majority of the pupils in this school who discussed their work with inspectors reported that they felt they were not good at technology and design.

3.2.4 Most of the specialist teachers interviewed during the survey visits recognised the need to motivate the pupils, particularly the girls. The survey findings confirm that in year 8 almost all of the pupils enjoyed technology and design but by year 10 only a small majority of the pupils were enthusiastic about the subject, and most of these were boys. Of the 5,467 pupils taking the subject at GCSE in 1999, 83% were boys and 17 % were girls. At the time of writing, many of the schools surveyed have reported that, as a consequence of their participation in the survey, planning to take account of the range of abilities in the classes and to meet more fully the needs and aspirations of the girls, is now under review.

3.3 Learning and Teaching

3.3.1 The majority of teachers of technology and design are conscientious, hardworking, and determined to do their best to support their pupils. In general, the new facilities provided under the ERP have improved the range and variety of the pupils' experiences and raised the morale of both the teachers and the pupils. A minority of teachers do not use the planning space associated with their manufacturing room and prefer their pupils to sit and work at the work benches in the manufacturing rooms. In almost every case in these circumstances, the pupils' books and written resource materials were not well enough maintained and the potential safe use of the facilities was compromised.

3.3.2 The quality of teaching seen during the survey visits ranged from unsatisfactory, in three instances, to outstandingly good. Table 1 below sets out the number of lessons seen along with the grades awarded and the grade descriptors. Of the 384 technology and design lessons observed, 17% had significant strengths, while in a further 41%, the strengths outweighed the weaknesses.

3.3.3 The lessons graded 1 were thoughtfully and effectively planned: the teachers had realistically high expectations of the pupils and took appropriate account of the pupils' prior knowledge of the subject, the specific objectives of the lesson, and the time available; they encouraged the direct involvement of the pupils through discussion, in both the conduct of the lesson and in the standards being achieved. Furthermore, the lessons were concluded effectively, with the teachers reflecting on the extent to which the knowledge content of the lesson was secure and, in practical classes, on the quality and standards of the pupils' work.

3.3.4 In a lesson graded 1, for example, a year 9 technology and design class investigated the graphical presentation of various household appliances using, simultaneously, isometric drawings and freehand sketches. Consequently, the pupils learned to sketch freehand by applying the rules and conventions of isometric projection. The quality and standards of the pupils' work was excellent in all respects. In particular, they took a pride in the neatness and accuracy of their drawings and in the tidiness of the folders which contained their work. The pupils discussed enthusiastically the advantages and disadvantages of orthographic and isometric projection and the concept of developing their own drawing style. In another technology and design lesson also graded 1, a group of less confident year 8 pupils learned how to use a cross-cut file. The teacher's demonstration and explanation established clearly the steps in the process to be followed and the standards of quality which were acceptable, and against which the pupils could make judgements about the quality of their own work.

3.3.5 In 29% of the lessons seen, the weaknesses outweighed the strengths, while in a further 12%, there were significant weaknesses. In the lessons in these categories, the teachers' expectations of the pupils were too low; the teaching was insecure or dull and frequently involved the pupils in transcribing large amounts of information from text books, or in the writing of dictated notes. In most of these lessons there was insufficient emphasis on practical work, especially designing and manufacturing. The pupils had few opportunities to discuss their work with the teacher; in addition, the pupils were unclear about the nature and relevance of the lesson content, and the standards which they achieved fell far short of the pupils' potential.

3.3.6 In a lesson graded 3 for example, the teacher introduced the use of a coping saw to a year 8 mixed ability group. The teacher's demonstration covered the holding of the saw and the position of the work-piece within the vice. He did not, however, emphasise the necessary operational characteristics to achieve a quality outcome, nor did the teacher allow the pupils to demonstrate the use of the saw in order to help identify the problems that they were likely to encounter when working on their own. Consequently, almost all of the pupils experienced difficulties in using the saw and achieving a satisfactory finish. The teacher spent the remainder of the lesson dealing with common problems on an individual basis. During the lesson, the pupils were casual in their approach to the task, they were restless generally, and the majority lacked the motivation and commitment to concentrate on achieving a good result.

3.3.7 In a lesson graded 4, pneumatics was the topic for a year 10 mixed ability technology and design class. The teacher's control of the class was generally ineffective and his teaching placed too much emphasis on the procedures for connecting various valves and cylinders to achieve a desired effect rather than ensure that the pupils had a sound understanding of the principles on which the components operated. Consequently, the teacher judged the success of the lesson against how well the pupils could remember the sequence of events. In addition, the pupils engaged in an excessive amount of transcription from text books. During the lesson, there were no opportunities for the pupils to discuss the operation of the circuits nor was there mention of the application of the systems to solving practical problems. By the end of the lesson, the pupils were disaffected and uninterested.

Table 1: Lessons seen with grades and grade descriptors

Lessons seen	Percentage of Total	Grade	Grade Descriptor
65	17%	1	significant strengths
157	41%	2	strengths > weaknesses
111	29%	3	weaknesses > strengths
46	12	4	significant weaknesses

3.3.8 On the evidence of the lessons seen, the most effective teaching of technology and design was typified by a range of factors, including the following:

- significant emphasis placed on practical work;
- good teacher-pupil relationships;
- detailed preparation taking into account the pupils' prior knowledge and skills;
- realistically high expectations;
- clear identification of the intended learning outcomes;
- interesting, meaningful and relevant technology and design activities;

- clear explanation and discussion supported by appropriate resources;
- standards identified clearly for designing, communicating and manufacturing;
- use of ICT to support and enhance learning;
- opportunities for the pupils to assess and improve their own work;
- careful consolidation of the pupils' learning at the end of the lesson.

The least effective teaching of technology and design was typified by a combination of some of the following factors:

- an over-emphasis on theory, the excessive use of text books, worksheets, transcription and, a concentration on knowledge of energy and control concepts in the absence of practical applications;
- poor teacher-pupil relationships, ineffective class control and too casual an approach to the lesson activities;
- the nature, purpose and the objectives of the lesson not being made clear to the pupils;
- low expectations and slow lesson pace;
- low standards set and poor quality of work accepted;
- the main content of the lesson clouded by irrelevant and unimportant information;
- too few opportunities for the pupils to discuss the lesson content and to contribute to the lesson outcomes;
- poor management of time and resources.

3.3.9 In almost all of the classes visited, whole-class teaching predominated. The teacher assembled the pupils in a single line around the demonstration bench, told the pupils what they needed to know to complete the activity and demonstrated the practical skills which they should learn. In a large minority of lessons, the teachers did not check to ensure that the knowledge was secure before the pupils commenced their practical work. In the best practice, the teachers questioned the pupils skilfully and provided ample opportunities for them to discuss and ask questions about the relevance and application of new information. Where appropriate, the teachers ensured that at least a few pupils had the opportunity to repeat practical demonstrations for the benefit of the whole class, in order to reinforce the lesson content and to show the potential difficulties in carrying out the practical task. In a minority of practical lessons, the teachers concentrated on the concept of quality and the factors which contribute to quality outcomes. In a few of the lessons seen, the pupils were sufficiently knowledgeable about quality and standards to make objective judgements about the quality of their own work and the work of others.

3.3.10 A minority of technology and design teachers use effectively a range of learning and teaching strategies, achieve an appropriate balance between practical and theoretical work, and set and maintain challenging, interesting and motivating tasks which take account of the pupils' abilities and needs. The majority of technology and design teachers have shortcomings in one or more of these important areas in their work. Only a minority of technology and design teachers take sufficient time to monitor and review the effectiveness of their work.

3.4 Range and Quality of the Pupils' Experiences

3.4.1 In a minority of schools, the pupils in KS3 are taught to plan their work in an increasingly independent and creative manner: at the end of the key stage, the pupils can investigate, generate and evaluate design proposals with a good measure of success. In particular, these pupils can use a design brief to guide their thinking, consider and record the most important and relevant factors in the design activity, specify clearly their design intentions, and propose, develop and appraise their design ideas.

3.4.2 In the majority of schools in KS3, problem solving through design activities is significantly underdeveloped. Almost all of the design opportunities created by the teachers involve the pupils in refining the shape of a part of an artefact, often with the intention of cosmetic improvement, rather than the improvement or refinement of the function of the product. In a few schools, design activity in KS3 is limited to the decoration of a product, often with emblems and logos unrelated to the departmental aims and objectives for the course. Consequently, in these schools, the pupils' competence to apply scientific and other organised knowledge to the solving of practical problems is poor.

3.4.3 All of the schools surveyed followed closely the assessment requirements for GCSE in technology and design. In the most successful classes, the pupils' folders showed that their efforts and time were focused appropriately on the generation and development of design ideas. In those schools where the examination results were significantly below the NI average for similar schools, the majority of the pupils concentrated inappropriately on the collection of product information and the identification and analysis of factors which had general relevance to all products and were not characteristic of the particular product or system under consideration. In the majority of schools, evidence from the pupils' GCSE folders indicated that the development of the design ideas was not systematically and progressively refined and developed enough to demonstrate sustained and justified improvement in the design of the products.

3.4.4 The quality of graphic communication skills has improved significantly since the publication of the Report on Secondary Education (1994). In the best practice at KS3, the pupils presented their ideas through the use of freehand sketches, and by the end of the key stage, through computer generated drawings. They were competent and confident in using line to create shape and form, and in modifying systematically and progressively, and improving, the functional and aesthetic aspects of their design proposals. Furthermore, they had the freedom and opportunity to express themselves and communicate with a third person, most often using plain paper and pencils and, increasingly, making effective use of a variety of media including ICT.

3.4.5 Nevertheless, in the majority of lessons, the pupils were not competent graphically to communicate effectively. In particular, the clarity of the information provided through drawing, and the accuracy and standard of the presentation was, too often, not good enough. In these cases, the teachers did not provide the pupils with opportunities to evaluate the clarity of the drawings with, for example, one of their peers: many of the pupils did not know the purposes of drawing products before manufacture. In a minority of the lessons seen, the pupils could not dimension their drawings in accordance with a recognised drawing convention, and annotate their drawings to enhance and clarify the design detail.

3.4.6 The quality of graphic communication skills in GCSE technology and design has also improved with the introduction of the focused task. The presentational drawing skills exhibited through this aspect of the course is having a positive influence on the appearance of the major design folder. Nevertheless, the overall standard of graphic communication skills, when judged against the clarity of the information contained within the drawing and the quality of presentation, needs, in general, to improve.

3.4.7 In nearly half of the schools surveyed, the pupils in KS3 have suitable opportunities to use a range of machines with an appropriate variety of materials. In the remainder of the schools, the use of wood is excessive, and the use of metal is minimal. Consequently, at the end of the key stage, the pupils are not competent to use metal effectively in their designing and manufacturing. In GCSE course-work, metal is underused significantly. In almost all of the schools surveyed, the teachers do not provide training for the pupils in both KS3 and KS4, in the use of the basic range of metalworking machines and processes. With very few exceptions, the pupils do not have the necessary skills to use oxy-acetylene welding and metal inert gas welding, nor do they have the necessary skills to use the machinery and tools to work metal effectively. In most cases, the teachers report that the provision of health and safety training to enable them to use the metal working equipment, is not matched to the availability of the equipment. Consequently, while the equipment has been supplied, the teachers are not permitted to use it until the essential training has been completed successfully.

3.4.8 In all of the schools, particularly at KS3, the pupils have suitable opportunities to work with thermo-plastics. While the process of vacuum forming is appropriate and relevant, the associated problems with the exposed edge have not always been well considered at the design stage. In the best but more time-consuming practice, the pupils are taught to fit and join rigid plastic in the construction of an outer case for an electronic or mechanical product. Often in these instances, the product is abraded, spray finished and dressed with an appropriate computer generated logo.

3.4.9 In most schools, the pupils learn to make good use of medium density fibre board to construct moulds and in some instances, to construct products and finish them effectively. Plywood and plastic laminates, however, are not used as often as they should be.

3.4.10 A majority of the pupils in year 10 have a sound understanding of the function and operation of basic electronic components and can construct circuits incorporating them. In addition, the same percentage of pupils understand the function and operation of basic mechanical systems including pulleys and gears. A minority of the pupils have a sound understanding of pneumatic systems and the function and operation of a variety of cylinders and valves. A minority also have the competence and confidence to use computers in control situations; few, however, have the opportunity to control their own designed and manufactured products.

3.4.11 The use of computers in technology and design is increasing each year with associated developments in the range and power of the resources. In about half of the schools surveyed, the pupils in KS3 have opportunities to use graphics software to formalise their design proposals. In most of the schools, computers were used to control external devices, for example, the programming of traffic, house and car lights. Very few schools allowed the pupils to control independently the operation of their own projects using the computer. In KS4, the teachers report that desk-top publishing, including graphics packages to present design proposals, has become the preferred medium for GCSE design presentation. Evidence from the survey shows that the standards of presentation have improved significantly over recent years, as has the quality of work in technology and design in general.

3.5 Management

3.5.1 In almost all of the schools surveyed, there is insufficient attention given to working with metal, consequently, a large proportion of the resources, representing at least 40% of the cost of provision, including machinery, tool and equipment, are significantly underused.

3.5.2 Over the past ten years, the ELBs have provided a range of safety training courses in the use of machinery, tools, specialised equipment and processes. While the provision of the programme of support has made a significant contribution to the teachers' confidence in the subject, the quality of provision across the five Boards is uneven and incomplete. In particular, too much emphasis is placed on the acquisition of craft knowledge with insufficient regard for the teachers' competence to sustain safe and effective use of the equipment. In addition, the duration of the training courses and the frequency of updating and consolidating new information and skills necessary to enhance the quality of provision in the classroom, need to be better.

3.5.3 All of the specialist teachers of technology and design have attended INSET courses specialising in subject knowledge and skills and the majority have participated in school based curriculum support. A majority of teachers have successfully completed a post-graduate certificate in technology education, a minority have completed a post-graduate diploma and a small number have completed a higher degree in the subject. A minority of teachers, however, are still insecure in their knowledge of the nature and scope of the subject and lack competence in designing and communicating graphically.

3.5.4 In the majority of the schools, the technology and design teachers meet regularly and frequently to plan their teaching schemes and to work together in the management and organisation of the department. In these schools, the teachers collaborate effectively to monitor and review the current provision, including the appropriateness of the homework policy, and to plan future developments. In a minority of the schools, consideration is being given to the implementation of self-assessment opportunities for the pupils. In these schools, the teachers are ensuring that in assessing the pupils' work, judgements are based, for the most part, on empirical evidence. In a small minority of schools, departmental meetings do not focus appropriately on matters relating to learning and teaching: in these cases, the leadership of the head of the technology and design department is not as effective as it should be.

3.5.5 On the basis of discussions with heads of technology and design departments, the scrutiny of departmental documentation and visits to lessons, the survey has identified a number of important management issues in relation to learning and teaching which need to be addressed more effectively. These issues include:

- the need to evaluate and review regularly and frequently the effectiveness of teaching and learning in order to inform strategies for improvement;
- the lack of opportunities for pupil self-assessment;
- the lack of objective evaluation of the pupils' technology and design capability;

- the pupils' limited knowledge of standards on which judgements are made;
- the lack of development of a shared understanding of the subject;
- the under-use of examination results as a management tool to effect improvement;
- the minimal contribution of the subject to the pupils' general education.

3.5.6 The allocation of curriculum time to technology and design at KS3 varies widely. On average, in non-selective schools, 6% of curriculum time is allocated to technology and design, and in selective schools, 4.8% of curriculum time is allocated to the subject. The guidance which has been published by CCEA recommends an allocation of 7.5% curriculum time at KS3 for all schools for technology and design. The survey findings show that where less than 7.5 % of curriculum time is available, the programme of study is not covered adequately, and, as a consequence, pupils progressing to follow the subject at KS4 are inadequately prepared.

3.5.7 About 80% of technology and design teachers are suitably qualified. The remaining 20% of teachers have not received sufficient health and safety training for basic workshop practice. Appropriate arrangements have been made by the ELBs to enable these teachers to gain an externally accredited City and Guilds qualification.

3.5.8 Almost all of the subject departments have technician support ranging from one to nine hours per week in 12% of the schools surveyed, to over 40 hours per week in 5.4% of the schools surveyed; 41% of schools surveyed had one full-time technician, exclusively for technology and design. The effectiveness of ancillary support varies widely: where the provision is less than one technician for every four subject teachers, the provision is inadequate. In the best practice, the technician is time-tabled to ensure that the departmental resources are regularly and frequently maintained and that class materials are prepared in advance; in addition, the technician and the head of department meet often to review the health and safety provision, to complete a safety audit and to review the stock of materials and the manufacture of teaching aids. The majority of technology and design technicians have had some industrial experience but very few have been appropriately trained to service a technology and design department. There is an urgent need to provide suitable training for technology and design technicians matched to their roles and responsibilities.

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

3.6 Accommodation and Resources

3.6.1 The accommodation for technology and design provided under the ERP is, in most cases, matched well to the needs of the schools and is adequate to facilitate the teaching of the subject in the NIC. In schools where the accommodation is not good enough, the provision is not matched adequately to the standards set out for technology and design within the DE's Building Handbook. In almost all of these cases, insufficient attention had been given to the alignment of the rooms and full wall-to-wall glazing to ensure that the pupils could be supervised across the systems room or planning room and the adjacent manufacturing room. In a few cases, the teachers' ability to supervise the pupils across the suite has been compromised by a high glass line at more than 1.1m off the floor level. In these schools, the pupils' opportunities to use machinery and equipment are limited to the resources within the room occupied by the teacher. The teachers report, and the survey visits confirm, that the restricted use of the facilities, particularly at KS4, is adversely affecting learning and teaching.

3.6.2 Since the introduction of the ERP, the quality of the machinery and tools supplied through the inter-Board tender has varied considerably in specification, quality and performance, ranging from domestic quality tools to industrial machines. While the quality of the heavy plant has improved recently, the physical size of the recommended machine sometimes exceeds the designated space set out in the Building Handbook and, consequently, it is not suitable for use in schools.

3.6.3 The teachers of technology and design report that improvements in accommodation and resources provided through the ERP have generally supported curricular developments in the subject. In particular, they have facilitated:

- increased opportunities to engage with " energy and control";
- improvement in the pupils' graphic communication skills;
- improvement in the pupils' range of manufacturing skills;
- increased use of information technology by pupils;
- more emphasis by teachers on the development of technological products.

The findings of the survey visits, and those from technology and design generally, confirm the schools' judgements as set out above.

4. DISCUSSIONS WITH OFFICERS FROM THE EDUCATION AND LIBRARY BOARDS

4.1 Paragraph 1.4 of the Introduction gives the background to the meetings, held in December 1999, which involved members of the Inspectorate with the SEOs and adviser(s) for science and technology and design from each of the five ELBs in NI. The paragraph also indicates that these meetings had provided a useful forum for the exchange of information and insights into the general outworkings of the ERP in science and technology and design.

4.2 The ELBs have used a range of mechanisms to identify the shortcomings in accommodation for science and technology and design in post-primary schools in the Controlled sector, and also to prioritise the order in which the shortcomings should be met using the ERP funding available. The adviser(s) for science and technology and design and/or specialist support officers have played an important role in this work. The DE has applied agreed criteria to identify the shortcomings in accommodation for science, and for technology and design, in post-primary schools in the Maintained and Voluntary Sectors. The adviser(s) for science and technology and design were willing to make their specialist expertise available to schools outside of the Controlled sector and, in most instances, this service has been welcomed and encouraged by the schools concerned. The rate of progress in dealing with the shortcomings in accommodation for the science and technology area of study has varied across the five ELBs. In most Board areas, the necessary improvements to the accommodation for science in post-primary schools has proceeded at an appropriate pace.

4.3 The relevant SEOs and advisers are aware that, in a minority of instances, laboratory refurbishments had involved the use of poor quality furniture and fittings; furthermore, there were important health and safety deficiencies in some of the proprietary laboratories installed. In addition, the specifications set out in the DE Building Handbook for science and technology and design rooms had not always been adhered to. For example, in a minority of technology and design suites, the lack of sufficient glass in the partitions between rooms made adequate supervision of the pupils impossible. Moreover, a number of undersized science rooms had been refurbished, often in the interests of expediency; in one Board area, for example, up to one-third of the refurbished laboratories had been undersized to begin with. In general, the schools involved were not always made aware, through a process of consultation, that such rooms limited, sometimes significantly, the class sizes in science for practical work by pupils. As already mentioned in paragraph 2.6.5, these circumstances point to the need for the consistent application of agreed quality control measures.

4.4 As stated in paragraph 2.6.6, most science departments in post-primary schools in NI do not have the basic level of provision of two computer systems per laboratory, as recommended by the DE in January 1998. Over recent years, however, progress has been made by the Boards in providing computers for use in science departments. Towards the end of the survey period, for instance, one Board made some £200,000 available to help achieve the provision of two computer systems per laboratory in each of the post-primary schools in its area. On the basis of this funding and similar developments in other Board areas, the science advisers should continue to encourage and enable science teachers to acquire and use computer hardware and software in support of learning and teaching in science. In general, the level of provision of computers within technology and design departments has improved significantly in recent years.

4.5 Over the past number of years, several factors have brought increasing pressure to bear on the capacity of advisers and field officers for science and for technology and design to sustain the still necessary high levels of specialist support in science, and in technology and design. These factors have included some reductions in subject-specialist staffing levels and an increasing need to provide support for whole-school issues such as literacy, numeracy and school development planning. In a majority of the ELBs, changes to the management structures and the redefinition of roles and responsibilities for specialist support staff, coupled with staff development and training opportunities, have helped to facilitate a balance between subject specialist support and support provided at whole-school level. In these ELBs, subject-specific support for science and technology and design has not been forfeited significantly at the expense of meeting the officers' commitments at whole-school level. Furthermore, while the practice and effectiveness are varied, the officers have, in general, been more proactive than reactive in meeting the needs of teachers and schools in science, and in technology and design, and have, in the main, been able to sustain a level of pastoral contact with the teachers of these subjects.

4.6 Schools have welcomed and benefited generally from the contact with the specialist advisers and field officers for science and technology and design. While the time allocated to them to meet subject specific demands varies from Board to Board, there is, in general, agreement amongst the SEOs that the advisers should spend the majority of their time in schools, with the remainder devoted to centre-based, INSET course design/delivery, and that the outworking of these arrangements should be subject to regular monitoring and review.

4.7 Over several years there has been an increasing level of inter-Board co-operation, culminating in the Inter-Board Strategy Framework which includes three-year development plans for science and technology and design. This encouraging level of co-operation should be sustained and developed in order to enhance further the support provided for schools in science and technology and design. In particular, there is a need to increase significantly the sharing and co-ordination of expertise, and teaching and learning resources in both subjects across the five Board areas. In addition, there needs to be more effective co-operation between the specialist support staff for science and those for technology and design, in order to encourage and achieve more co-operation between the teachers of science, and of technology and design, in post-primary schools.

4.8 The advisers of science, and of technology and design, report that the improvements achieved to date through the ERP in the accommodation for both subjects has had a positive impact on teacher and pupil morale; in schools which have benefited from the ERP funds in science and technology and design, the teachers are no longer preoccupied with deficiencies in specialist accommodation and are, in general, beginning to concentrate on improving learning and teaching and the raising of standards. The significantly broader curriculum for technology and design in recent years could not have been implemented in schools without the accompanying changes to specialist accommodation made possible through the ERP. The advisers of science are keen to consider an early revision of the current schedule for science laboratories contained within the DE Building Handbook, especially to decide the best way to facilitate the use of computers in support of learning and teaching within a science laboratory.

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

5. PRIORITIES FOR ACTION

5.1 The survey has established a number of priorities for action for science and for technology and design. These priorities will need to be addressed in a co-ordinated way by the specialist subject teachers, post-primary schools, CASS and the DE if the pupils' experiences and the standards they achieve in the two subjects are to continue to improve. The priorities are set out below: some are unique to science and some unique to technology and design; others, however, are common to both and, therefore, have been set out as priorities for action within the context of the area of study. Each priority is cross-referenced to the corresponding paragraph within the main body of the report; and the priorities for science and for technology and design are grouped under the sub-headings of Planning, Teaching and Learning, Range and Quality of the Pupils' Experiences, Management and Accommodation and Resources.

5.2 Science

5.2.1 Planning: the need for

- schemes of work in science to contain more explicit reference to intended learning outcomes (2.2.1);
- improved planning for AT1 (2.2.1);
- improved planning to guide curricular collaboration between the teachers of science in post-primary schools and their counterparts in the contributory primary schools (2.2.2).

5.2.2 Learning and Teaching: the need for teachers of science to

- use a broader range of learning and teaching strategies (2.3.5);
- achieve a better balance between practical and theoretical work (2.3.5); and
- raise their expectations of the standards which their pupils can achieve (2.3.5).

5.2.3 Range and Quality of the Pupils' Experiences: the need to

- raise the profile afforded to the implementation of AT1 (2.4.4);
- improve the pupils' ability to plan successfully and carry out investigations in a logical manner and to make informed observations (2.4.4);
- enhance the pupils' ability to formulate hypotheses, to apply scientific knowledge in unfamiliar contexts and to evaluate scientific evidence objectively (2.4.4);
- increase the opportunities for pupils to record their thinking, observations and findings in science using their own words (2.4.5);
- improve the pupils' ability to apply their understanding in science to moral, social, economic and environmental issues (2.4.5);
- enhance the contribution of science to developing the pupils' skills in literacy, numeracy and ICT (2.4.6);
- improve the continuity in the pupils' learning in science across the key stage 2/3 interface (2.4.6);

- reduce significantly the number of pupils following a limited grade single award GCSE science course (2.4.8);

- improve the quality of the pupils' experiences in practical work (2.4.18).

5.2.4 Management: the need to

- improve the leadership of the head of science in a small minority of schools (2.5.1);

- address a range of issues linked to departmental management; including the role of heads of science as middle managers in post-primary schools (2.5.2);

- improve communication amongst the teachers of biology, chemistry and physics, especially at KS4 (2.5.4).

5.2.5 Accommodation and Resources: the need to

- overcome the shortcomings in science accommodation in a significant minority of schools (2.6.2, 2.6.3 and 2.6.5);

- improve the resources for ICT in science (2.6.6);

- increase the level of technical support for science (2.6.7).

5.3 Technology and Design

5.3.1 Planning: the need to

- improve the planning for the single attainment target for technology and design (3.2.1);
- meet better the requirements of the NIC for technology and design at KS3 (3.2.2);
- increase the uptake of technology and design by girls at KS4 (3.2.4).

5.3.2 Learning and Teaching: the need for

- more effective use of the planning and systems rooms to support learning and teaching (3.3.1).

5.3.3 Range and Quality of the Pupils' Experiences: the need to

- raise the standards of design and communication skills achieved by the majority of pupils by the end of KS3 (3.4.5);
- improve the development of design ideas for GCSE course work (3.4.3);
- increase the training for pupils in the use of metal (3.4.7);
- raise the level of use of computers by pupils to control practical devices made during project work (3.4.11).

5.3.4 Management: the need to

- improve the quality of safety training for teachers of technology and design across the five ELBs (3.5.2);
- enhance the knowledge of a minority of teachers of technology and design of the nature and scope of the subject and to improve their competence in designing and communicating (3.5.3);
- increase the instances of self-assessment opportunities for pupils (3.5.4);
- improve departmental leadership in technology and design in a small minority of schools (3.5.4);
- increase the allocation of curriculum time for technology and design at KS3 (3.5.6);
- provide suitable accredited training for technicians (3.5.8).

5.3.5 Accommodation and Resources: the need to

- increase the provision of glazing to facilitate the supervision of pupils (3.6.1);
- improve the quality and appropriateness of machinery and tools (3.6.2).

5.4 Area of Study: the need

- for improved planning to take account of the abilities and interests of individual pupils (2.2.2 and 3.2.3);
- to improve the extent of curricular collaboration between the teachers of science and the teachers of technology and design (2.2.2);

- to enhance the coherence in the pupils' learning across the area of study (2.4.6);

- to reduce the wide variation in the quality of teaching (2.3.2, 2.3.3, 3.3.2 and 3.3.3);

- to increase the time taken by the teachers of science, and the teachers of technology and design, to monitor and review the effectiveness of their work (2.3.5 and 3.3.10);

- for the more consistent application of agreed quality control measures in order to ensure that the specifications and layout drawings for all new and refurbished accommodation for science and for technology and design comply fully with the requirements of the DE Building Handbook (2.6.5, 3.6.1 and 4.3);

- increase the level of proactive contact of science advisers and technology and design advisers and their support staff with science and technology and design departments in post-primary schools (4.5);

- for the further development of the strategic, inter-Board approach to the in-service training provided for the science and technology area of study (4.7).

6. CONCLUSION

6.1 The ERP has been a qualified success; for example, since the introduction of the programme there have been significant improvements in the accommodation for science and technology and design in a majority of post-primary schools and this has raised the morale of the specialist teachers and pupils involved in both subjects. In general, too, there has been a sustained trend of improvement in the standards achieved by pupils in both subjects at GCSE level over the last five years. There have also been improvements in learning and teaching in both subjects.

6.2 However, as the priorities for action set out in section 5 show, significant improvements are still required and the pace of improvement in learning and teaching in both subjects has not matched the pace of improvements made to the specialist accommodation for science and technology and design. Furthermore, many of the priorities echo the priorities for action identified previously in the 1994 report 'Secondary Education 1994: Science and Technology: A Report by the Inspectorate'. A concerted, co-ordinated effort on behalf of schools, CASS and the DE will be required to ensure that these priorities are dealt with urgently and to move to a situation where they cease to form part of the agenda for improvement in science and technology and design.

6.3 The report indicates that there remain shortcomings in the accommodation for science, and for technology and design, in a significant minority of post-primary schools. Furthermore, some of the work already undertaken through the ERP will need to be revisited, either to replace poor quality furniture and fittings or to ensure that the requirements of the DE's Building Handbook are fully met, especially in relation to matters of health and safety.

6.4 The circumstances set out in paragraph 6.3 confirm the need for the DE to continue the ERP until such times as key shortcomings in accommodation which are inhibiting teaching and learning in science, and in technology and design are addressed. In addition, more consistent application of agreed quality control measures will be required to ensure that any finances made available are spent with maximum efficiency and to maximum effect.

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

APPENDIX

ERP Survey: Schools Visited

Strathearn School, Belfast: Feb 1999

Clounagh Junior High School, Portadown: Feb 1999

St Joseph's Boys' College, Enniskillen: Feb 1999

St Patrick's High School, Lisburn*: Feb 1999

St Mary's Grammar School, Magherafelt*: Feb 1999

St Cecilia's College, Londonderry: April 1999

St John's High School, Dromore, Co Tyrone: May 1999

St Joseph's College, Belfast: Sept 1999

St Louis Grammar School, Ballymena: Sept 1999

St Colm's High School, Draperstown: Sept/Oct 1999

Dunluce High School: Sept/Oct 1999

Cullybackey High School: Oct 1999

Portora Royal School, Enniskillen: Oct 1999

St Michael's Grammar School, Lurgan: Oct 1999

St Joseph's College, Plumbridge: Oct 1999

La Salle Boys' High School, Belfast: Oct 1999

Wallace High School, Lisburn: Oct 1999

St Columba's College, Portaferry: Nov 1999

Assumption Grammar School, Ballynahinch: Nov 1999

Strabane Grammar School: Nov 1999

Lisnaskea High School: Nov 1999

Monkstown Community High School, Co Antrim: Nov 1999

St Mary's College, Irvinestown: Nov 1999

Sullivan Upper School, Holywood, Co Down: Dec 1999

Tandragee Junior High School: Dec 1999.

* Survey work undertaken as part of a general inspection of the school.

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

PHOTO REDACTED DUE TO THIRD PARTY RIGHTS OR OTHER LEGAL ISSUES

Copies of this report may be obtained from the Inspection Services Branch, Department of Education, Rathgael House, 43 Balloo Road, Bangor, Co Down BT19 7PR. A copy is also available on the DE website: www.deni.gov.uk