Looking at Junior Cycle Science

Teaching and Learning in Post-Primary Schools

PROMOTING THE QUALITY OF LEARNING

AN ROINN OIDEACHAIS AGUS EOLAÍOCHTA | DEPARTMENT OF EDUCATION AND SCIENCE
INSPECTORATE

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Foreword

Science and its applications are fundamental to the way in which we live our lives today. Science education seeks to equip young people to live in a world that is increasingly scientifically and technologically orientated. Indeed, the goal of "scientific literacy for all" has become a primary objective of a general education.

The introduction of the revised syllabus for junior cycle Science in 2003 was one of a number of steps taken by the Department of Education and Science to enhance teaching and learning in the subject and to improve student uptake of Science generally. The syllabus is activity-based in its design, and emphasises that students have to engage in a variety of investigations and experiments so that that they have opportunities to develop appropriate science process skills as well as knowledge of underlying concepts. The introduction of the syllabus was complemented by substantial expenditure by the Department of Education and Science on improved laboratory facilities in schools and by the work of the Junior Science Support Service, which provided professional development programmes for teachers.

This report, *Looking at Junior Cycle Science*, provides an insight into the implementation of the syllabus by reporting on the outcomes of over sixty subject inspections carried out by the Inspectorate between 2004 and 2006. The report shows that much progress was being made on the implementation of the syllabus, although the extent of investigative work being undertaken at that time was limited in a number of schools. Its analysis of the quality of subject provision, planning, teaching, learning and assessment of the subject will be most helpful for teachers and schools as they review their own practice. It will, I hope, be of interest also to those involved in preparing and supporting teachers of Science, and all who have an interest in this most important subject.

Dr Cearbhall Ó Dálaigh
Deputy Chief Inspector

Chapter 1

Introduction

1.1 Background

Looking at Junior Cycle Science is based on the outcome of subject inspections carried out by inspectors of the Department of Education and Science in post-primary schools in the years 2004–06. As well as commenting on current practice in post-primary science education, the report is aimed at promoting good practice in schools. By encouraging professional dialogue among those interested and involved in science education, this report aims to enhance the teaching and learning of Science in schools. The report is intended as a resource for teachers, schools, and education policy-makers.

Subject inspection reports from sixty-three post-primary schools that were inspected over the two-year period to June 2006 were analysed in the preparation of this report. Most of the reports were on inspections that took place outside whole-school evaluation (WSE). Many of the reports also included material on senior-cycle science subjects. In the preparation of this report, as far as possible, information relevant only to junior cycle Science was used. The report also draws on information and evidence on general trends observed by inspectors during those inspections. The schools inspected include urban, rural and suburban schools in twenty-two counties.

Schools by category	Voluntary secondary schools	35	56%
	VEC schools	16	25%
	Community and comprehensive schools	12	19%
	Total	63	100%
Schools by gender	Co-educational schools	34	54%
	Single-sex schools		
	Girls' schools	13	21%
	Boys' schools	16	25%
	Total	63	100%
Schools by size	More than 500 students	27	43%
	From 200 to 500 students	22	35%
	Fewer than 200 students	14	22%
	Total	63	100%

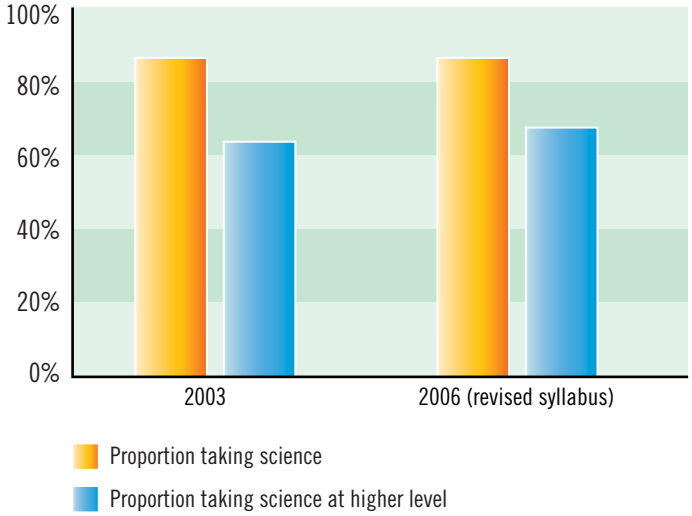
The revised junior-cycle science syllabus, introduced in 2003 and first examined in 2006, places an emphasis on students' practical experience of Science. This is reflected in the introduction to the syllabus, which states:

> The course is activity based in its design and emphasises practical experience of science for each individual student. The importance of the processes of Science as well as knowledge and understanding is reflected in the syllabus structure. Through a variety of investigations and experiments, students attain the specified learning outcomes, developing appropriate science process skills and a knowledge of underlying science concepts (Department of Education and Science, 2003, p. 3).

An extensive programme of professional development provided by the Junior Science Support Service (JSSS) facilitated the introduction of the syllabus. It was also supported by teaching and learning resources prepared by the JSSS. The Department of Education and Science provided additional grants to schools for the purchase of equipment, general materials, and chemicals. Each school within the Free Education Scheme received a standard grant, based on the number of junior science laboratories in the school; and further grants, based on identified needs, were paid to schools that had not received capital investment since 1995.

The Junior Certificate examination in 2006, based on the revised science syllabus, marked a new departure in the assessment of Science. In line with the aims of the syllabus, students' coursework was allocated a proportion of the marks in the examination. Of the 57,944 Junior Certificate candidates in 2006, 49,947 (86%) took Science. Of those taking the Junior Certificate examination in the revised science syllabus, 67% took it at the higher level. For comparison, the proportion of Junior Certificate candidates taking Science in the 2003 Junior Certificate examination was 86%, and the proportion taking it at the higher level was 63%. This increase in the proportion of students taking Science at the higher level is encouraging.

Fig. 1: Proportion of candidates taking Junior Certificate Science and those taking Science at higher level, 2003 and 2006



Science is taught in almost all post-primary schools, and 90% of junior cycle students studied the subject in the school year 2005/06 (93% of boys and 87% of girls). The chief examiner's report on the Junior Certificate examination for 2006 states that girls who take Science are more likely to take it at the higher level. Girls also performed better than boys in the examination.

1.2 Subject inspection

Subject inspection aims to develop quality teaching and learning and, through this, students' achievement in Science. A subject inspection report on Science evaluates the teaching and learning of Science in a school. It considers the planning and preparation for teaching at the level of the subject department and the level of the individual teacher. It also includes commentary on the school's provision for and support of Science.

Subject inspections are carried out in line with the provisions of *A Guide to Subject Inspection at Second Level* (Inspectorate, 2004). The inspections in Science take place over one or two days. During inspections the inspectors meet the teachers of Science and the school principal. They also attend a number of lessons and examine students' work and the science teachers' planning for Science. The facilities and resources in the school for the teaching of Science are inspected. During the inspection feedback is given to each teacher, and at the end of the inspection the inspector meets the science teachers and the principal, generally together. At this meeting the findings of the inspection and the recommendations for the further development of Science in the school are discussed.

Chapter 2

The quality of subject provision and whole-school support

2.1 Teachers of Science

The most important resource for schools in the teaching and learning of Science is the teacher. The number of science teachers in a school (including teachers of Leaving Certificate science subjects) depends on the size of the school. The inspectors' reports showed that in the majority of schools, class groups for Science had the same teacher for second year and third year and, to a lesser extent, for first year. In almost all schools the same teacher taught the entire science syllabus.

In a few schools subject specialists taught the physics, chemistry and biology components of the syllabus separately. This arrangement has potential for sharing the expertise of subject specialists and for team teaching, but while it worked well in some schools, the inspectors commented that it sometimes led to a lack of continuity for students.

Effective procedures for the induction of teachers new to a school can make an important contribution to the quality of their work. An induction process gives them the information they need to become effective members of the school staff. The schools inspected had a wide range of practice for the induction of teachers. Some schools had no formal induction, but often the principal, the deputy principal or a post-holder acted as a mentor. Others provided new teachers with an induction day, and many had formal mentoring systems, some of which had links with universities.

The inspectors found that schools generally encouraged and facilitated teachers in their continuing professional development (CPD). In many instances they paid for membership of professional associations. However, in a small number of schools the teachers had not attended CPD events.

Schools should place a high priority on CPD, especially that organised by the JSSS or the Second-Level Support Service (SLSS). Where teachers cannot attend they should be briefed by their colleagues. The inspectors also felt that schools should adopt the practice (seen in some schools) of using expertise within the school to further enhance teachers' professional development.

> CPD is strongly supported in the school. All science teachers have attended inservice training and are actively encouraged and facilitated to pursue additional inservice if available.

> Though it is school policy to encourage and facilitate teachers to avail of opportunities for in-career development neither of the teachers has been able to avail of the current in-service programme organised in conjunction with the introduction of the revised Junior Science syllabus.

Features of good practice

- Students have the same teacher for each part of the science syllabus
- There is an induction programme for teachers new to the school
- Teachers are encouraged and facilitated in their professional development by the school management
- Teachers' expertise is used within the school in providing continuing professional development

Concerns

- Teachers in some schools are not attending CPD events

2.2 Science: Option or core?

More than two-thirds of the schools inspected had Science as a core subject. In some schools it was a core subject in first year only, or all students took it for part of first year, for example as part of a taster programme. In schools where Science was an optional subject the number of students choosing it was generally high. In the minority of schools where there was a low uptake of Science, this issue needs to be addressed.

In a small number of schools it was a matter of concern that not all students had the option of choosing Science. For example, in one school that streamed its students, Science was offered only to those in the upper streams. This practice adversely affects students' options for the senior cycle. Of concern also was the finding in the recently published Inspectorate evaluation of the Junior Certificate School Programme that fewer than half the schools in the JCSP offer Science to their JCSP students (Inspectorate, 2005, p. 72). As one inspection report commented:

> It is recommended that the school reassess its policy on the elimination of Science from the timetable of students who opt for the Junior Certificate School Programme.

Where it may not be feasible for students to take Science as a subject in the Junior Certificate examination, JCSP science profiling statements should be used. These statements relate strongly to students' everyday experiences, and they facilitate active learning through the practical activities included. Their use would give all students the opportunity to experience Science.

The inspectors expressed concern where students were required to make choices about a range of subjects new to them before entering post-primary school. For example, some

schools required students to choose between Science and Home Economics before their entry to the post-primary school. Having to make uninformed choices of this nature without the opportunity to sample the subjects concerned is not in the best interest of a student. One of the ways in which schools address this issue is through a taster programme in first year that gives students an experience of new subjects, including Science. However, one drawback of taster programmes, especially those of more lengthy duration, is that they can lead to the time allocation for Science and for other subjects being below syllabus requirements.

Good practice was in evidence where schools based the subject option groups from which students chose at the end of a taster programme as closely as possible on students' preferences. In these instances science teachers and guidance counsellors were active in helping students to make their choices, and parents were often involved through the holding of an open night. Guidance counsellors had a central role in conveying to students an appreciation of the value of Science as part of their general education and an understanding of the range of options that Science creates in the senior cycle and after leaving school.

The inspection reports showed that most science classes were taught in mixed-ability settings which is preferable at this level.

Schools and teachers were finding that teaching classes of mixed ability was challenging. It called on skills of differentiation with regard to curriculum, class management, teaching methods and assessment so as to have the best possible learning experience for each student. In some schools mixed-ability classes were formed in first year (or in first and second year), while separate classes for ordinary level and higher level were formed for subsequent years. The inspectors recommended that schools and teachers avail of the professional development provided by the SLSS in the area of mixed-ability teaching.

Features of good practice

- Where Science is optional, students are given an experience of Science before making choices
- Science is open to all students in the school
- Subject option groups are based on students' preferences
- Parents and guidance counsellors are involved when students are making subject choices
- Class groups for Science are of mixed ability
- The school makes use of the DES support services

Concerns

- Not all schools give students the opportunity to take Science
- In a small number of schools, few students are taking Science
- There are schools in which the study of Science is confined to upper-stream students
- The number of schools offering Science to JCSP students is low
- Students are required in many schools to choose from a range of new subjects before entry
- Teachers find teaching mixed-ability classes to be challenging

2.3 Resources for teaching

Among the principal material resources for Science are laboratories, equipment, ICT, and displays of science-related material in science teaching areas. Most schools had laboratories that were well stocked with equipment and materials and had adequate storage and preparation areas. Gas, water and electrical services in these laboratories were generally in good working order.

However, the laboratory facilities in a minority of schools were not fully adequate for the teaching and learning of Science. In some of these schools the provision of new laboratory facilities was at the planning or building stages. The modernisation of existing facilities for Science, including the upgrading of gas, plumbing or electrical installations and laboratory furniture, was also taking place in some schools. Many schools had availed of funding available through various schemes funded by the Department. Typical comments in a number of reports included the following:

> The school has three laboratories which share one large storage/preparation area. These are well kept and in good condition.

> Two older laboratories and a tiered demonstration room have been supplemented with two new laboratories completed during the current school year.

> The Science laboratory, demonstration room and the associated storage/preparation areas have been recently refurbished as part of an upgrading of all the practical rooms within the school.
>
> Funding has been sought for the refurbishment and upgrading of the laboratories. There is a need for additional laboratory facilities which are proposed as part of the school's current building programme.
>
> The school has received a grant of over €16,000 to deal with significant deficits in laboratory equipment which were identified in conjunction with the implementation of the revised Science syllabus.

The inspectors found that school managements were generally supportive of the needs of science departments. The majority of laboratories were well maintained. Science departments in some schools were given an annual allocation so that they could budget for the upkeep of laboratory facilities and for restocking. This approach facilitated departmental planning and was encouraged by the inspectors. In the majority of schools, however, requests for money for equipment and materials were met as they arose.

Good practice was observed in many schools regarding the orderly storage of materials and the maintenance of laboratory preparation areas. Examples cited in the reports included the storing of laboratory resources in an accessible manner, assembling kits of materials for specific topics or experiments, and the use of trolleys for storing or moving equipment. A typical example from one report was as follows:

> Laboratory resources are neatly stored in an accessible manner which facilitates the completion of practical activities by students.

However, the inspectors found that a more systematic approach to the storing of equipment and regular stocktaking was needed in some schools. One report commented:

> A scheme for storage needs to be implemented. All obsolete materials and equipment should be removed to make way for new materials.

Some schools also stated that they had difficulties with regard to sharing equipment between laboratories, especially if they were not adjacent to each other. A very small number of schools had the services of laboratory technicians or assistants to help in the organising of laboratories and the preparation of students' practical work.

The great majority of the schools inspected had made use of the additional departmental grants for the purchase of equipment and materials for Science. It was regrettable that a small number of schools had yet to spend this money at the

time of the inspections. This had resulted in some schools having deficiencies in the equipment required for students' practical activities. The inspectors commented that the schools concerned should address this issue as a matter of urgency in the interest of their students.

The inspectors reported that ICT facilities for Science, including internet connection, computers, and data projectors were available to an increasing extent in schools and that science laboratories were being incorporated in schools' upgraded broadband facilities. The availability of interactive whiteboards and data projectors in some newer laboratories was also noted. However, ICT facilities could be improved in many schools. While most schools had computer rooms that were available for science lessons, they were rarely used for this purpose.

An aspect of ICT that is particularly relevant to Science is data-logging. The *Discover Sensors* programme, led by Discover Science and Engineering, is being gradually expanded with the aim of eventually including all second-level schools. The use of data-logging can enhance students' experience of practical work and provide them with more time for the analysis of practical results, and teachers are encouraged to develop its use with their students. However, the inspections showed that the potential of ICT in the teaching and learning of Science has yet to be realised fully. It is expected, however, that ICT will be used to a much greater extent as resources in schools develop and as teachers develop their ICT skills. Reports encouraged teachers to seek training in applications of ICT through local education centres and the SLSS. School managements were also encouraged to facilitate science departments in meeting their ICT resource and training needs. A typical comment from a report was as follows:

> It is recommended that the science department be facilitated in further exploring and planning for the use of ICT in the teaching and learning of Science. Such planning could include the identification of suitable resources as well as identifying training needs and appropriate methodologies for incorporating ICT into classroom practice to ensure that the most effective use is made of such resources.

In many schools the learning environment was enhanced through displays of science posters in the laboratories and on the corridors, and in some schools students' projects were on display. In general, however, there was scope in schools for more use of visual stimuli, such as posters, charts and project work developed by the students.

Features of good practice

- There is adequate funding of the school science department
- There is orderly storage of the science teaching resources
- There is adequate maintenance of facilities for Science
- Equipment kits are prepared for specific syllabus topics or experiments
- Science facilities are incorporated in the school's broadband system
- There are displays of posters, charts, and students' project work

Concerns

- Laboratory facilities in a small number of schools are inadequate
- Stocktaking is held at irregular intervals in some schools
- A small number of schools have not spent the money allocated to them by the DES for Science
- There are deficiencies in some schools with regard to science equipment
- The potential of ICT for science teaching and learning is not yet realised

2.4 Health and safety

The majority of schools had a safety statement drawn up by outside experts, approved by the board of management, and reviewed every one or two years. Time was allocated to health and safety issues at staff meetings in some schools. However, all schools need to ensure that science facilities are included in their safety statements. Safety statements in some schools were out of date and in need of review.

The publications *Safety in School Science* and *Safety in the School Laboratory,* published by the Department of Education and Science in 1996 and amended in 2001, and the *Review of Occupational Health and Safety in the Technologies in Post-primary Schools,* published by the Department and the State Claims Agency in 2005, provide important guidance on health and safety matters and should be examined carefully by schools. One inspection report commented as follows:

> The Health and Safety statement refers only very briefly to the science laboratories. Hence, it is recommended that the school updates the statement to include appropriate references to the health and safety provision in the refurbished science rooms.

The inspectors found that schools varied in the extent to which they met health and safety requirements. There was a significant difference between the facilities in new schools and those in some older schools that had not been

refurbished, in particular with regard to the storage of chemicals. There was evidence of good practice in many schools, with chemicals being stored securely according to the recommended storage groups. In a small number of schools chemicals were stored in the laboratory, because of a lack of storage facilities. Inspectors expressed concern that in some schools chemicals were stored in unlocked presses rather than in a well-ventilated, secure facility. In these instances the schools were urged to review and upgrade their storage arrangements.

Laboratories in many schools were well equipped with appropriate safety equipment, and a high level of attention had been given to ensuring a safe working environment. This included in some instances an assessment of safety issues and the testing of electrical equipment. Some members of the school staff were trained in administering first aid, in carrying out fire drills, and in the correct use of fire extinguishers. Shortcomings observed in health and safety requirements in some schools included isolation switches for gas and electrical supplies not being available or being in unsuitable places, and in some instances eyewash bottles not being available. An inspection report from one school included the following:

> The school should review the storage of chemicals to ensure that they are stored in accordance with best safety practice.
>
> The school's commitment to the ongoing upkeep of the laboratories is evident in the installation of a pressure proofing system to ensure the safety of the gas supply. The laboratories are well equipped with appropriate safety equipment such as fire extinguishers, fire blankets, and first aid kits.
>
> Some issues, such as the location of the isolation switches for the gas and electrical supplies in the storage/preparation room were observed. Hence, it is suggested that the science teachers would review the current provisions for health and safety in the laboratories with a view to identifying and prioritising any deficiencies and planning for their resolution.

Features of good practice

- Time is allocated at staff meetings to health and safety
- Chemicals are stored securely according to recommended storage groups
- Laboratories are equipped with appropriate safety equipment
- There is an assessment of safety issues
- Staff training on safety is provided
- Safety issues are taken into consideration in students' laboratory work
- Laboratory rules are displayed and complied with

Concerns

- Safety statements are not always up to date
- The storage of chemicals is a potential safety issue in some schools
- There are deficiencies in some schools with regard to safety equipment

The inspectors reported that teachers gave a high priority to the active management of safety issues during students' practical work. For example, students wore safety glasses and laboratory coats. Laboratory rules were displayed and health and safety regulations were adhered to in the great majority of laboratory classes. The inspectors recommended that schools review laboratory rules regularly, distribute them to students, and ensure that they are attached to the students' laboratory notebooks.

2.5 Allocating resources: The timetable

Schools generally allocated teaching time to Science in accordance with the requirements of the syllabus, and almost all schools scheduled double lesson periods to facilitate students' practical work. However, the inspectors noted a number of timetabling arrangements that were less satisfactory. In some schools science lessons were allocated single periods only. While this may have been unavoidable in some circumstances, the inspectors believed that this restricted the extent to which students could experience an investigative approach to learning Science. These schools were urged to include a double lesson period for each science class each year.

> The number of class periods is below syllabus requirements for first-year students. It is recommended that class contact arrangements for first year be reviewed.

In a small number of schools the inspectors were critical of timetabling arrangements that meant that students had infrequent contact with the subject. Some of these schools had scheduled two double lesson periods for Science each week; in others, students had more than one science lesson in a day or had all their science lessons over two consecutive days. These arrangements meant that students did not experience science lessons on a regular basis.

In some schools first-year students had only two or three lesson periods each week for Science, which meant that the time allocation was below the requirements of the syllabus. Schools were urged to provide students with their full time allocation for the subject, including just one double lesson period, and with lesson periods spread over the school week.

With some exceptions, the number of students in the science classes observed was appropriate for the carrying out of practical work. In some schools this appropriate class size was achieved through forming additional classes for Science, for instance by dividing five class groups into six groups. In the small number of instances where the number of students in science classes was too large to permit effective laboratory work, schools were advised to re-examine their approach.

Schools differed with regard to access to laboratories for science students. In a small number of schools not all science class groups had access to laboratories each week. In some instances class groups were scheduled for access less than once a week, while in others access to laboratories was arranged informally, with some practical activities being carried out in general classrooms. Laboratories in some schools were assigned to individual teachers, and the majority of those teachers' classes were held in the laboratories. In a few instances this practice had the effect of restricting access by other classes to the laboratory.

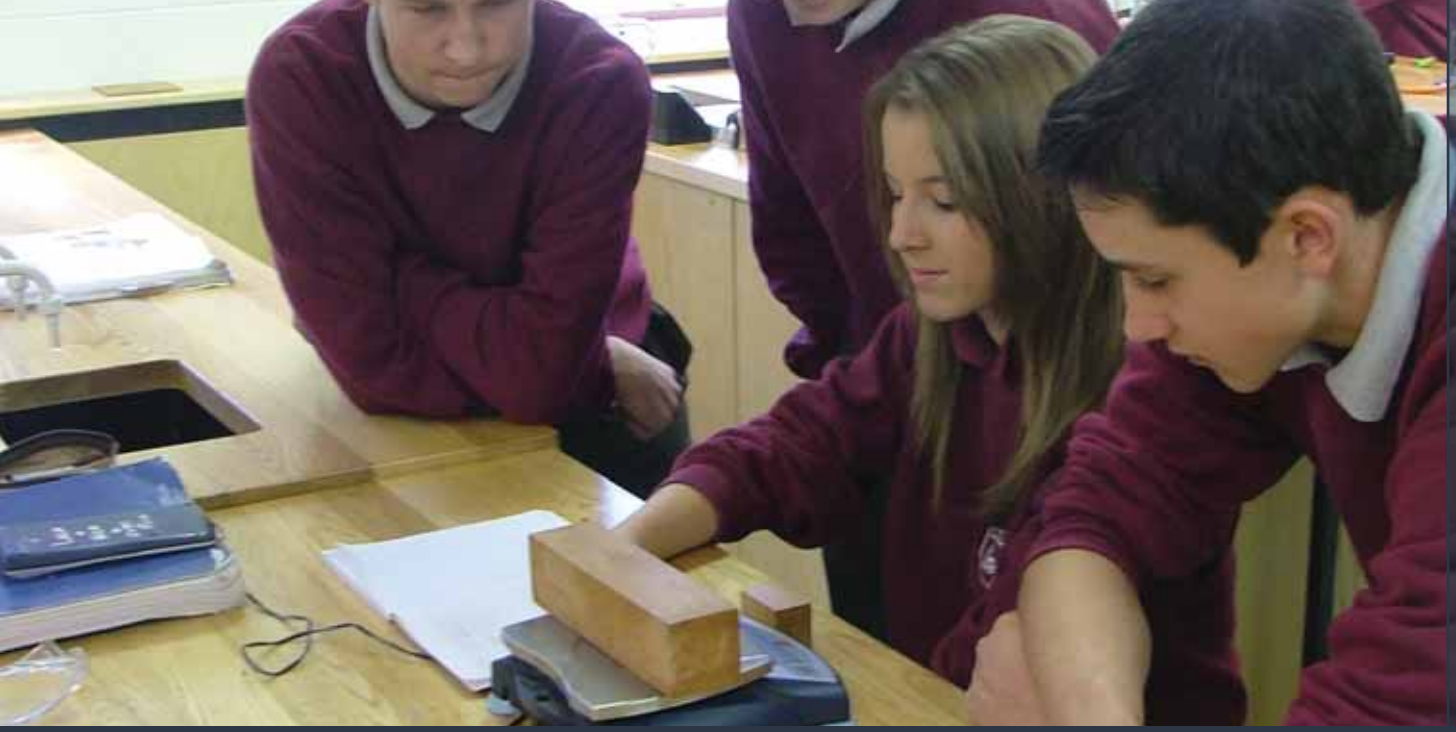
In schools where best practice was observed, access to the laboratory was timetabled, and laboratories were used exclusively for science lessons. Access to science laboratories should in all instances be formally timetabled so as to ensure optimal and equitable access for all junior-cycle science classes.

Features of good practice

- Double lesson periods are provided for students' practical work
- Lessons are spread throughout the week
- There is regular timetabled access to laboratories for practical work

Concerns

- There are single lesson periods only for Science in some schools
- The time allocation for Science is below the requirements of the syllabus in some schools
- Class sizes are too large for practical work in a small number of schools



Chapter 3

The quality of planning and preparation

Science teachers worked as a subject department in most schools. They very often worked together as a team to plan the teaching of Science and to prepare resources. In many schools the teachers also co-operated in the assessment of Science. In some schools collaboration among science teachers had developed to the preparation of a science plan for the school. This collaborative planning complemented individual teachers' planning and lesson preparation.

3.1 Science subject department

Planning in school science departments usually took place as part of the school development planning (SDP) process. School managements were generally very supportive of planning in Science and facilitated the science teachers in working as a department.

Practice with regard to the organisation of Science in schools varied from occasional informal meetings of teachers to the holding of regular formal meetings and the development of a science department plan. The frequency of departmental meetings varied from one each year to one or more each term. The inspectors noted an increasing trend towards subject departments developing agendas for meetings and keeping records of such meetings. They recommended that brief records be kept of matters that were discussed, as such records help to ensure continuity in the organising of the work of a school's science department.

Among the topics discussed at departmental meetings were common year plans for Science, the ordering of equipment, common examinations, and students' progress. Examples of inspectors' comments included:

> A very good level of planning for the provision of Science is evident in the work of the science department. The department is clearly structured and meets regularly. An annual report from the science department is a useful means of reviewing the work of the department and of informing [the] management of relevant issues.

> The initiative shown in promoting the work of subject departments through school development planning is to be commended. For example, the science department has already been surveyed on issues such as textbooks, curriculum, homework, resources, and assessment.

> An agenda is decided and minutes are recorded for all meetings of the science team, which is good practice.

> A science co-ordinator is appointed on a rotational basis which gives each member of the science team an opportunity to manage and co-ordinate the department on a yearly basis. This is laudable practice.

The inspectors believed that formal planning in science departments had produced commendable results, including the provision of comprehensive folders containing information on safety legislation and procedures, stock control guidelines, seating plans, and monthly schemes of work. In a small number of schools planning was being carried out at the level of the individual teacher only. The inspectors recommended that school managements encourage the development of science departmental planning as a support to the planning of individual teachers for teaching and learning.

3.2 Teamwork, leadership and co-ordination

The inspectors reported that there was very good teamwork in the majority of science departments. Teachers co-operated with regard to laboratory access, teaching resources, and the sharing of teaching methods. Where schools had a science co-ordinator, the science department was well organised. The position of co-ordinator was a voluntary role in the majority of schools, and in a small number of schools the role was linked to a post of responsibility. Where the position rotated among science teachers, each had an opportunity to co-ordinate the work of the department.

There was scope for improvement in the co-ordination of science teaching in many schools, however. For example, in some instances the main focus of subject specialists was on the senior cycle subjects and there was little co-operation at junior cycle level.

Features of good practice

- Science teachers work collaboratively as a subject department
- Agendas and records are kept of departmental meetings
- Teachers co-operate with regard to laboratory access, teaching resources, and the sharing of teaching methods
- There is a co-ordinator for the science department

Concerns

- Planning for Science takes place only at the individual teacher level in some schools
- The main focus of teachers is on senior science subjects, with little co-operation in the junior cycle in some schools

3.3 Collaborative planning

Collaborative planning by school science departments is supported by resources provided by the School Development Planning Initiative. Schools showed considerable variation in

the extent to which collaborative planning took place for Science. The spectrum of practice varied from co-operation with regard to selecting texts and common work plans for each science year group to the development of a comprehensive science plan for the school. In general, there is a highly encouraging trend towards a greater extent and depth of planning among the members of school science departments. However, in many schools there was still considerable scope for development in this area.

> However, the scheme of work for Junior Science focuses exclusively on content by listing the topics to be covered with each year group. Hence it is recommended that the science teachers continue to build on the good work already completed and further facilitate the sharing of good practice by developing a shared programme of work for the revised Junior Science syllabus which could bring together planning for methodologies, assessment, resources, co-curricular and extracurricular activities, etc.

As part of the development of a science department plan, teachers in a few schools had compiled shared folders of resources, such as notes, overhead transparencies, and assessment materials. In some schools common examinations had been agreed. One report noted:

> The compilation of shared folders of resources such as notes, overhead transparencies or assessment materials is a particular feature of the operation of the science department and is to be highly commended.

Through working together, science teachers can more effectively and more efficiently share resources and benefit from the work of their colleagues. Science teachers in some schools were collaborating in developing a central resource area for Science. Common resource boxes of equipment for practical work had been prepared in many schools. Common approaches were frequently taken to the implementation of Coursework B for the Junior Certificate Science examination.

An example of collaboration with regard to teaching methods reported in one school was the development and testing by teachers of a strategy for enhancing students' skills of observing, predicting and explaining. An initiative such as this creates an opportunity for the sharing of professional knowledge and experience. When developing collaboration with regard to teaching methods, science departments should begin with a small project with clear aims and use the outcome as a basis for further co-operation.

In this regard it should be noted that the JSSS has recently provided all school science departments with their own dedicated web space to facilitate collaborative planning and the developing and sharing of resources. The web space may also be used to share resources between schools. This facility has significant potential for the development of science education, and teachers are encouraged to take advantage of the opportunities it offers.

The inspectors suggested that, as schools develop their collaborative planning, such issues as teaching methods for Science, stock control, the storage and safety of equipment and materials, students' practical work and strategies for meeting the needs of students with special educational needs should also be included. The inspectors also pointed to the need for a continuous evaluation and review of subject planning.

A number of inspection reports advised that the work of science teachers in collaborative planning should result in the development of a longer-term science plan for the school that included the policies of the science department. The plan should include reference to the subject's aims and objectives, timetabling, class organisation, resources, homework policy, and support for students with special educational needs. The science plan should also incorporate programmes of work for science classes that include detailed lists of the topics on the syllabus, associated practical activities, time allocation for the coverage of each topic, and a list of appropriate resources. Teaching, learning and assessment methods should also be documented. Other areas that should be included in the science plan are the use of ICT in the school and co-curricular and extracurricular activities in Science.

Features of good practice

- Common resources for Science are prepared
- There are common approaches to assessment
- There is collaboration with regard to teaching methods

Concerns

- There is scope for a greater involvement of teachers in joint planning in many schools

3.4 Individual teachers' planning

Individual teachers' planning for the teaching and learning of Science takes place in the context of collaborative planning by school science departments. This means that teachers and students benefit from the partnership and sharing that is part of the development and implementation of a science department plan within a school. However, the considerable variation observed among schools in the level and extent of departmental planning meant that in some schools planning for teaching and learning took place only at the level of the individual teacher. Although individual teachers' planning varied considerably in its extent and its quality, in general the practice by individual teachers of keeping term or annual

teaching plans was increasing. There is a need, however, for further development in this area.

Most teachers maintained class records, including attendance rates, assessment results, homework tasks, records of practical classes, and records of students' behaviour. Some teachers made use of ICT in record-keeping. The inspectors noted the important role that good records of assessment results can play in providing teachers with a profile of students' progress and achievement over time. These records are essential for the review by teachers of the achievement of learning outcomes and thus for informing teaching and learning. They are also an essential support for differentiation in teaching and learning. Profiles of students' progress may also be used in making decisions on subjects and levels of subjects for students.

Features of good practice

- Teachers keep good and comprehensive records

Concerns

- There is a need for further development in the planning work of individual teachers

Chapter 4

The quality of teaching and learning

4.1 Planning for teaching and learning

The evaluation of teaching and learning in this chapter is based on the observation by inspectors of approximately four hundred science lessons. Effective teaching and learning involves planning for individual classes, using a range of teaching methods to develop students' understanding of the subject, having a well-ordered environment conducive to learning, and making appropriate use of resources. In the case of a practical subject, such as Science, students' practical work needs to be organised so as to achieve optimal learning. As with all other subjects, it is necessary to take into account the range of students' needs and abilities.

Teachers' short-term planning for the lessons observed was generally very good. They frequently used resources from the JSSS in the detailed planning of teaching and learning. Lessons were well structured, with clear aims and objectives, and effective use was made of resources. The resources used for lessons included lesson plans, worksheets, overhead projector transparencies, ICT, and science apparatus. While in some lessons there were deficiencies in relation to preparing resource material, the quality of planning that was generally evident in lessons enhanced teaching and learning by giving pace and structure to lessons.

There was good practice in many schools in the setting of aims, objectives and the learning outcomes for science lessons. Teachers used whole-class teaching at the start of many lessons to set the scene and to clarify with students the objectives and expected learning outcomes of the lesson. In this way learning was made more purposeful, and self-assessment by students of their learning could take place. The topics covered in almost all lessons were appropriate to the learning outcomes being sought.

4.2 Teaching methodologies

The inspectors found that, in general, lessons were clearly communicated and contained a good balance between theory and practical activities. In many theory-based lessons, scientific concepts were presented in a stimulating manner that took account of the range of students' abilities. The teachers used a wide range of methodologies, and many also included links to relevant issues outside the classroom as well as links to students' prior learning. The board, overhead projector, hand-outs, worksheets and class discussion were used to communicate to students the content of lessons in a comprehensible manner. In some lessons, teachers made use of ICT. Other methodologies in use included students' practical work, teacher-led demonstrations, group work, and questioning.

To engage students actively in lessons, teachers used practical investigations, question-and-answer sessions, word games, and differentiated worksheets. Such activities enhanced students' enjoyment of Science while also increasing their confidence with scientific knowledge.

In a small number of schools the range of methods used by the teachers was limited, and lessons were more teacher-centred and did not accommodate the different learning styles of students. Teachers should include in their planning of lessons provision for a range of methods that address more than one learning style.

> At times where the lesson became more instructional, the methodologies used were not varied and did not allow for different learning strategies or accommodate different learning styles.

> A variety of appropriate learning activities was organised including: practical investigations, question and answer sessions, word games and differentiated worksheets. These activities served to enhance the students' enjoyment of Science while also increasing their confidence with scientific literacy.

Question-and-answer sessions were used at the start of lessons to create links with material covered in previous lessons. Other uses of such sessions were to introduce new topics and to determine the level of students' prior knowledge. Good practice was also observed in the use made by teachers of students' questions or comments to progress the content of lessons.

In the majority of schools the questioning of students was successful in focusing their attention on the lesson. Teachers who used questioning in an effective way directed questions towards encouraging students' higher-order independent thinking as well as seeking factual responses. For example, closed questions were used to probe students' level of knowledge, while more open-ended questions required them to demonstrate their understanding of the particular topic.

As well as directing questions to the entire class, some teachers also directed questions to individual students. The strategy of allowing the entire class to consider a question before requesting a named student to provide an answer was also used effectively. In general, the inspectors recommended that greater use be made of questions directed to individual students, as this would reduce the amount of chorus answering, help focus students' attention, and maintain a high level of engagement and enthusiasm. It would also facilitate the formative assessment of students.

Teachers made the lesson topics relevant to students through frequent references to the application of the lesson content in

the everyday world. Examples of this were where students were encouraged to discuss issues such as the effects of smoking on the human body, the use of sun-blocks to protect against ultra-violet radiation, and the use of chlorine to kill bacteria in swimming pools. Another example was the use made of a local habitat near the school so as to link the concepts being taught with students' daily experience. Where best teaching practice was observed, new material was linked to earlier learning and to the daily lives and experiences of the students.

Features of good practice

- Resources from JSSS are used in the detailed planning of teaching and learning
- Objectives and expected learning outcomes are clarified for students at the start of lessons
- A range of teaching methods is used
- Students engage actively in lessons
- Students' questions or comments are used to progress lessons
- The topic is made relevant to students and linked to previous learning

Concerns

- Lessons are teacher-centred, with limited variation in the teaching methods used

4.3 Differentiation

Most science lessons take place in an environment where students of a range of abilities and interests were in the class group. Through differentiated teaching the teacher takes into consideration the variation in the background knowledge of students, their readiness and interests, and responds to these with the aim of maximising each student's learning. Two examples from the reports were as follows:

> Attention to the literacy needs of younger students was evident in the use of simple everyday terms initially before the more complex scientific terms were introduced later in the lesson.

> Classes observed displayed a range of abilities and differentiated teaching methods observed included some one-to-one attention, directed questioning, spelling and writing key words on the blackboard. In addition, communication regarding student progress in Science occurs on a regular basis with the special needs teacher.

The use by teachers of differentiated teaching methods was observed in some schools. In others they were not evident. The methods observed included one-to-one attention, directed questioning, and spelling out and writing keywords on the board. In some schools the teachers reported that a significant number of students had poor English-language skills, and this was also evident in some lessons visited. Where students have a deficit in English-language skills this needs to be considered in the planning for lessons.

Appropriate and useful strategies that were seen in schools included simplified notes on relevant topics and the use of visual stimuli to illustrate and develop the content of the lesson. In one school, laboratory equipment that was frequently used was labelled and placed on display at the side of the laboratory. Another example was the use of word banks in the student's first language, accompanied by the words in English. Teachers in some schools also adapted their assessments to suit individual students' abilities.

The inspectors noted that managing students' practical work gave teachers the opportunity to supervise individual students and to give appropriate attention to students of all abilities. Good practice was observed where the teacher circulated among students as they worked, guiding, advising, and affirming their work. It was noted that teacher-student interactions took into account the ability level of each student, with assistance being provided to students who were experiencing difficulties or who had questions. Where teachers acted as facilitators they had the opportunity to verify students' understanding individually or within groups through observing and asking them questions. In many schools the teachers also encouraged students to reflect on their observations, to draw appropriate conclusions, and to hypothesise possible outcomes in other situations.

The development of materials for differentiated teaching can be facilitated through collaboration in subject planning to provide additional hand-outs, worksheets, tests, and other stimuli. In many schools there was also supportive contact between subject teachers and members of the learning-support department. Schools are recommended to seek the advice of the SLSS and the Special Education Support Service (SESS) in order to develop further the expertise of their staff with regard to differentiated teaching.

Features of good practice

- A range of methods is used to address the learning needs and styles of students
- Teachers use students' practical work as an opportunity to give attention to individual students
- There are strong links between the subject department and the learning-support department

Concerns

- There is an absence of emphasis on differentiation in many schools

4.4 Use of resources

Teaching resources were used in science lessons to enhance students' learning by catering more effectively for their range of learning styles. In lessons that did not have a focus on students' laboratory work, teachers used such resources as textbooks, the board, ICT, worksheets, and hand-outs. The inspectors reported that effective use was made of the textbook in many lessons, such as where students were directed to the main points in the text after the material had been covered in the lesson. However, the inspectors expressed concern about the use of textbooks where a considerable proportion of the lesson was taken up with students reading aloud from the book. The inspectors advised that the most appropriate role for the textbook was to supplement and reinforce learning and teaching already completed during the lesson.

The board was used effectively in many classrooms to highlight the key points of lessons and to collate students' contributions. Examples of this were its use to clarify lesson content using simple illustrations and notes on essential terms. In lessons where some students have literacy difficulties it is suggested that unconnected lettering (rather than cursive handwriting) be used when writing notes on the board. Good use was also made of the overhead projector in lessons, for instance to emphasise important points before starting students' experimental work.

The inspectors reported that teachers had incorporated ICT to a greater extent in the teaching and learning of Science as a result of the resources and training provided by the JSSS. Teachers had shown considerable commitment in developing such material, and the inspectors noted particularly effective use of ICT in many schools. Presentations using the data projector were most effective when the objectives of the presentation were clear and were appropriate to the topic being taught. An example of this was the use made in one science lesson of the internet to produce pictures of plants that students were able to identify using an appropriate key.

Schools and teachers were strongly encouraged to continue broadening their range of ICT resources and the extent to which they integrated the use of ICT in all aspects of teaching and learning. The inspectors emphasised that students should have an opportunity to interact with the technology rather than being passive recipients of information mediated by it. An example was the good practice evident in one school:

> Teachers had placed their notes on a shared [disk] drive that students could access and had included lists and links to web sites for each topic.

Visual stimuli and the use of audiovisual resources can be very effective in illustrating and conveying concepts in Science. The inspectors reported that in most lessons the teachers used visual stimuli, such as diagrams, posters, or models, effectively. Such demonstrations by the teacher were also used to clarify the objectives of lessons and to engage students' interest. For example, during a presentation on transpiration the movement of water molecules was illustrated clearly in a short video extract that was integrated in the presentation.

Worksheets and hand-outs were used frequently to assist in the development of lessons. Among these were materials obtained from the JSSS, together with other materials that had been developed by the teachers themselves. As well as focusing students on tasks they served to emphasise areas with which students had difficulties. Worksheets were also used between various stages of practical activities to develop students' understanding of the practical work being performed. In some lessons a structured worksheet was used to steer the final discussion on a topic or a laboratory experiment, including the recording of findings and the answering of related questions.

Science teachers were commended on the commitment they had shown in developing these teaching aids, and the inspectors encouraged teachers to share these materials with colleagues through collaborative planning.

Features of good practice

- Students are directed to the essential points in the textbook for review following lessons
- Students' literacy difficulties are accommodated through clarity in board work
- Presentations using ICT have clear objectives

Concerns

- Lessons are based solely on the textbook in some classes

4.5 Classroom organisation and management

The organisation and management of classroom activities has a strong influence on students' experience in learning Science. Effective classroom management produces a level of order and discipline that is conducive to learning. It also has a significant effect on the atmosphere of the classroom, which

is influenced by the extent of affirmation of students' efforts and the degree of their participation in lessons.

The inspectors reported a good working atmosphere in the great majority of the lessons observed. Students received a high level of individual attention and positive reinforcement.

There was very good rapport between teacher and students in most classrooms, and in many lessons the students showed strong enthusiasm for the subject. Addressing students by name added to this positive atmosphere. Students readily asked questions of their teachers and participated in the lessons. Other indications of a positive classroom atmosphere were the high level of attentiveness, co-operation and good behaviour observed during lessons. One report noted the following:

> Some excellent examples of warm, enthusiastic, inclusive teaching that rewarded all efforts was observed. In these lessons student self-esteem was particularly well enhanced and nourished through the use of encouragement and constructive feedback, and hands were continually raised in an eagerness to contribute.

Teachers were generally very affirming of students' work and responses. Good practice was observed in the attention and support given to individual students when they were answering questions in class and in the use made of students' contributions. There were many examples of praise and encouragement by teachers A typical comment was as follows:

> All students engaged enthusiastically with their tasks and the nature of all lessons was all-inclusive. The needs, abilities and interests of students were harnessed in a way that made the learning of Science an active, interesting and relevant subject.

Students' work was affirmed also through awards systems operated by many schools. In a small number of schools, however, a greater emphasis could be placed on the affirmation of students' efforts. The level of participation was generally very high in the lessons visited by the inspectors. In some schools the teachers used relevant practical activities and teamwork among students to generate these high levels of participation. In many schools students asked questions during their lessons, and this led to further engagement. Some teachers fostered participation through using a problem-solving approach to the theme of the lesson and making use of encouragement and constructive feedback.

When teachers are planning lessons they need to take into consideration how they can encourage students' engagement. Teachers should involve students in lessons, for example through displaying visual images of the material

being presented, or through questioning. In some instances the inspectors suggested changes to classroom seating arrangements as a means of promoting further engagement. Other approaches include involving students in group work, class discussion or debate, in preparing their own notes, or in working at the board.

In some instances where a teacher-centred approach was taken to the teaching of the lesson there were occasions, especially during theory classes, where students became passive for a prolonged period. In such instances the inspectors suggested the adoption of a range of strategies that would require a more active level of participation by students in the lessons.

In many lessons a balance was maintained between teacher-centred and student-centred methods, for example where the teaching of theory and its applications was followed by independent work by students in solving problems. In lessons where the teacher promoted independent learning and responsibility by students for their own work, students requesting assistance were encouraged and challenged to propose their own solutions. During other lessons they were given the space and time to work independently, for example on worksheets, computer programs, and calculations.

Approaches such as these encouraged independent thinking and the development of problem-solving skills and therefore a deeper understanding of Science.

Features of good practice

- Individual students are affirmed, supported, and encouraged
- There is a balance between teacher-centred and student-centred teaching methods
- Students are given the opportunity to work independently
- High expectations of students are set

Concerns

- There is a teacher-centred approach to lessons
- There is a lack of opportunity for students to contribute in many lessons

Students were generally attentive and co-operated with their teachers throughout lessons. Most lessons observed had a disciplined atmosphere, where students observed a clear and fair code of behaviour. Clear classroom instructions ensured that lessons were well managed and that students were actively engaged. High expectations were set in relation to work ethic and behaviour, and students remained focused on the task during lessons. Lessons were generally well paced

and took into consideration the abilities of students. All these factors contributed to maintaining a calm environment conducive to productive work. Cases of indiscipline in the lessons observed by inspectors were few.

4.6 Organisation and management of practical activities

Practical laboratory activities in Science help to reinforce students' understanding of the subject. They also help students to develop a further range of skills. They reflect the aim of the revised science syllabus, which is "to provide opportunities for observing and evaluating phenomena and processes and for drawing valid deductions and conclusions."

Investigations observed, such as students' practical activities and teachers' demonstrations, were generally well organised and facilitated the development of students' understanding and skills. One report noted the following for example:

> The provision of practical activities is greatly facilitated by the manner in which laboratory equipment and materials are organised. For example, resources such as microscopes and glassware are neatly stored in an accessible manner in labelled presses, resource kits which contain all the necessary materials for a specific activity have been created, and a clear system for identifying resource needs on an on-going basis is in place.

Teachers supported and facilitated students either individually or in small groups during practical sessions. In some instances, however, the inspectors expressed concern about the adequacy of the time allowed for the completion of investigations. In some instances the inspectors judged that it would have been better to ask students to write up accounts of practical activities as a homework exercise than to take up laboratory time with this task. In general, an appropriate emphasis was placed on safety considerations in practical activities, and the inspectors observed that students were confident and adept in completing their tasks.

Practical work was generally organised as a group activity, with pair work being very effective in engaging students. It was noted that students worked collaboratively and demonstrated communication skills in such group settings. They were seen to be planning, designing and carrying out their investigations, sharing their solutions to questions or problems, and taking good records. They often assisted also in setting up and putting away the apparatus for their investigations. In some schools, however, there was a need for a greater involvement by students in setting up their investigations through improved laboratory organisation.

> Students demonstrated good command of the scientific method and an understanding of what was required of them and were observed to be planning, designing and implementing their investigations in small groups. Students were observed to be sharing their solutions readily and to take good records. By the end of the lesson there was a real sense of fulfilment among the group that they had satisfactorily achieved the aim of the investigation.

Good practice in carrying out practical work was in evidence where students showed a command of the scientific method and an understanding of what was required of them. Good practice was also observed when students were encouraged to observe and record their observations as they worked and when there was an emphasis on the use of a control and the concept of a fair test. In some instances the students were encouraged to discuss a variety of methods of carrying out an investigation before deciding on one particular method.

Excellent practice was observed where students led the feedback to the whole class on the work they had carried out. This practice acted as a stimulus to motivation and allowed the students to develop a culture of learning from each other as well as from their teachers. The use of such a session near the end of a practical class, where students share and discuss their results and conclusions, under the teachers' guidance, should be considered for all practical classes.

> Students' results were recorded on the board during a plenary session facilitated by the teacher. This practice allows students to learn from each other and can provide further learning opportunities through exploring reasons why results vary or are similar.

An objective of the science syllabus is that students should develop the skills required for preparing and presenting reports on practical activities. There was quite a variation in practice in this area. In some schools the students copied the description of practical activities directly from the textbook or wrote it up before the investigative activity. In others, students' reports of their practical work were in their own words—an approach that is in line with the aims of practical work in Science.

The inspectors commented that a greater emphasis needed to be placed on the development of students' report-writing skills. As well as writing an account of the work they have done they should be encouraged to include a description of the planning they have undertaken for experiments. In many schools elements were missing from students' practical copybooks, and it was apparent in some schools that some students had fewer mandatory investigations recorded in their notebooks than others in the same class. This was a source of some concern.

However in some cases it was observed that student notebooks had not been monitored and students tended to copy the description of practical activities directly from the textbook. The development of the skills required for preparing and presenting such reports is an objective of the revised Junior Science syllabus. Hence, it is recommended that the science teachers be facilitated in considering this issue with a view to coming forward with proposals for developing students' skills in report writing and increasing the level of monitoring of such work.

In all circumstances the student should be reminded of the importance of the completion of the written account of the investigations for Coursework A of the revised science syllabus.

Demonstrations of practical activities by the teacher were used in many lessons for revision purposes. However, the inspectors noted that the purpose of such demonstrations is to complement and not to replace investigation by students. The inspectors stated that the practice seen in a small number of schools of having demonstrations by the teacher as the main form of practical activity was contrary to the principles of the revised syllabus. This was a source of concern, given that resources for students' practical work were available to schools and that there was enough access by students to laboratories in almost all schools. In schools where demonstrations by the teacher have been overused to the detriment of students' own investigative work, practice needs to be changed to ensure that students complete prescribed practical work as required by the science syllabus.

Features of good practice

- Students set up and put away the apparatus for their investigations
- Students prepare their own reports on practical work
- There is a feedback session at the end of a practical class

Concerns

- Descriptions of experimental procedures are copied from the textbook, or a report is written up before the performance of practical work
- There is a lack of emphasis in some schools on developing students' report-writing skills
- Demonstrations by the teacher are used in some schools to replace students' practical work

4.7 Special educational needs

In some schools the inspectors found that the science and learning-support departments had worked together in planning for students with special educational needs. In these schools teachers had an awareness of those students who required learning support, and they liaised with the learning-

support or special needs co-ordinator in developing strategies for facilitating these students in the classroom. It was evident from the level of use of scientific and technical language by these students that attention had been given to its correct use in teaching and learning. A typical comment in reports on these schools was:

> Teachers have an acute awareness of the students in their lessons who require learning support and demonstrate a willingness to liaise with the special needs co-ordinator in order to ascertain the specific difficulties of the students concerned and to develop strategies to support them in the classroom.

Many teachers, however, while aware of the differing needs of individual students, did not adopt an appropriate teaching strategy for addressing them, even though there had been whole-staff training in special educational needs in co-operation with the SESS. In these schools communication between the science department and the learning-support department was inadequate. Such schools were strongly encouraged to develop links between the science and learning-support departments so that students' science education needs were fully met.

Shared strategies among school departments should be developed, including the use of ICT, which could be used to further alleviate literacy difficulties and any other learning difficulties among science students. For example, greater use could be made of simple worksheets to introduce content as well as for assessing students' progress. Students could also be assisted in developing personal glossaries of new or complex words associated with each topic.

Features of good practice

- There is joint planning between science and special educational needs departments

Concerns

- Many teachers lack appropriate teaching strategies for students with special educational needs

4.8 Enhancing learning through extracurricular activities

Many schools organised a range of activities that enhanced the provision for Science and helped to develop students' interest in the subject and its everyday applications and potential. The inspectors noted instances where speakers from Enfo and An Taisce had visited schools and where schools had organised visits to local businesses and industries. Many schools had built up strong links with third-level

institutions. Schools had also participated in events that promote careers for women in science and engineering. Students had taken part in many activities, including ecology field trips, recycling projects, industrial visits, Science Week activities, science quizzes, and visits to Dublin Zoo and the W5 centre in Belfast. The dedication and work of many science teachers in co-ordinating such activities were highly commended.

Many schools had extended students' learning in Science outside the classroom in a variety of ways. The profile and status of Science in many schools was raised by such whole-school initiatives as hosting a Healthy Eating Week. Students had been involved in the BT Young Scientist and Technology Exhibition, the Young Science Writers' Competition, and the various international science olympiads. Schools also participated in An Taisce's Green Schools scheme, which aims to improve the school environment and to raise awareness of environmental issues. A science notice board for staff members and students to encourage involvement in co-curricular activities that promote attitudes and achievement in Science was evident in some schools and this could be readily extended to others.

4.9 Students' learning and achievement

The inspectors reported that almost all the lessons observed were appropriate to the science syllabus and that the majority of lessons were directed at achieving clear learning outcomes for students.

In many theory-based lessons the inspectors reported that teachers secured the active engagement of most students, for example through the use of ICT presentations and through encouragement and good teacher-student rapport. In lessons where high expectations of work and behaviour were set it was evident that students were focused on the task at hand and were learning. In a small number of instances, however, it was noted that too informal an atmosphere during lessons adversely affected students' concentration. On some occasions also, especially during theory lessons where there was little variation in the activity, students became passive and were not engaged by the lesson. In general, the inspectors judged that in most lessons observed most students were learning.

The inspectors examined students' work and in most cases judged that it showed an appropriate level of development of their skills and knowledge in Science. Many students were

confident and capable in answering questions put to them during the inspectors' visits. In general, in practical lessons students were seen to be confident and adept at completing assigned tasks. However, as stated earlier in this report, the inspectors were concerned that students in some schools were not learning about science in an investigative way, as required by the syllabus. There was a concern also that they were not developing the skills of writing reports in their own words on the practical work carried out. The chief examiner's report on the Junior Certificate Science examination for 2007 (State Examinations Commission, 2007) expresses some concern about the performance of some students in the coursework element of the revised syllabus, which reflects some of the inspectors' observations.

The low proportion of students in many schools taking Junior Certificate Science at the higher level gives rise to disquiet about their level of achievement in Science. Findings from educational research suggest that teachers' expectations can and do affect students' achievement and attitudes. Schools and science departments are encouraged to explore the role of teachers' expectations as a factor in students' achievement with a view to developing more positive attitudes to Science and to increasing students' expectations of themselves. As part of this, all schools should monitor the uptake of Science at the higher and ordinary levels and encourage students to take the subject at the higher level where feasible.

Features of good practice

- A range of activities is organised to enhance students' science education
- Teachers have high expectations of students

Concerns

- Only a small proportion of students in some schools are taking Science at the higher level

Chapter 5

The quality of assessment

5.1 Assessment in the classroom

Assessment is an intrinsic part of teaching and learning in Science. Appropriate assessment methods and the use of the results of assessment to inform teaching and learning are important determinants of the quality of teaching and learning.

The inspectors reported a wide range of assessment practices in use with science classes. Generally, schools and science departments assessed students' progress regularly through questioning in class, teachers' observation, class tests, and formal school examinations. Teachers also frequently administered class assessments when individual topics had been completed. Continuous assessment, project work and the marking of homework were also used. Collaboration among teachers of Science was evident in schools that had common school assessments for each year group. Such assessments were an indicator of successful joint curriculum planning and co-ordination, and the inspectors recommended that this practice be extended.

> Good practice was evident in the sharing among the science department of the responsibility for setting examinations and devising marking schemes.

A combination of formative and summative assessments, spread throughout the year, is an effective method of monitoring the performance of students. Formative assessment, or assessment for learning, can be carried out on an ongoing basis by questioning in class and through the correction of homework.

While excellent use of assessment for learning was observed in some lessons, there was a lack of it in others. Some of the samples of assessment viewed during inspections contained evidence of formative comment-based marking, an approach that has been shown to be more effective in developing students' understanding than either the assigning of marks or a combination of assigning marks and comments (Black and Wiliam, 1986). Examples of assessment for learning practices were also evident in students' notebooks. Useful comments by teachers provided valuable feedback to students on their progress and affirmed work well done. The inspectors also observed that students who received frequent assessments had a greater understanding of their ability in Science. The inspectors recommended that teachers include provision for formative assessment in all lesson plans, that they use assessment frequently, and that they provide regular feedback to students. They also encouraged the use of comment-only marking. They suggested that the practice of assessment for learning could be further developed by schools through staff

development days and by making use of the information available on the web site of the NCCA. Inspectors' comments included the following:

> Best practice is applied in terms of feedback on formative and summative assessments and parents are kept very well informed of student progress. Students are given directive oral feedback on homework and tests in class. House exams are marked, graded and given a written comment which is a laudable method of encouraging students and giving direction.

> While excellent use of assessment for learning was observed in some lessons, there was a lack of it in others. It is recommended that all lesson plans include a means of carrying out formative assessment of students.

The inspectors reported that many schools carried out an analysis of results in the State examination, either at the school level or the subject department level. In these schools the State Examinations Commission's marking schemes and chief examiners' reports were used to inform curricular planning, including assessment. However, the inspectors noted that the use of marking schemes and chief examiners' reports could be more systematic and widespread.

The practice of careful and consistent recording of assessment results was widespread in schools. Typically, such data was recorded in teachers' journals and used over time to build up a profile of students' progress and achievement.

Features of good practice

- There is collaboration among teachers with regard to students' assessment
- There is formative comment-based assessment of students' work
- State Examinations Commission material is used to influence teaching and learning

Concerns

- There is a need for a more consistent emphasis on formative assessment in all classes

Schools had different strategies for following up on the outcomes of student assessment. In some schools students were interviewed by the principal and a letter was sent to parents when students were considered to be underperforming. These students were supported by pastoral care structures that included advice from the year head or principal. Part of the follow-up included a discussion of the outcomes of assessments with students, who were then encouraged to set personal goals and to work towards them. Parents were kept informed throughout the process. An example in the reports included the following:

> All assessment outcomes are systematically recorded in the teacher's journal. This good practice helps to build a profile of

students' progress and achievement in the subject over time. It is commendable that these profiles are used by the teacher to provide advice on examination levels to students and parents.

The contact that teachers of Science had with the parents of students frequently began with an information evening for the parents of incoming first-year students. As students progressed through school the parents were kept informed of their children's progress through parent-teacher meetings, students' homework journals, telephone contact, letters, school newsletter, school web site, and written reports following formal assessments. In some schools progress reports on individual students were prepared at the request of parents.

5.2 Assessment of practical work

The inspectors found a wide variation in practices concerning the assessment of students' practical work. In a small but growing number of schools, practical work was assessed and a portion of the marks was included in the marks for end-of-term school examinations. The inspectors recommended that this practice be adopted by all schools, as it encourages high standards in practical work by rewarding students' commitment. It also accords with the rationale underlying coursework in the revised science programme.

In some schools students' practical work had been included in a scheme of continuous assessment, and teachers assessed the performance of practical work through interaction with students as they worked. Teachers also assessed practical work by monitoring laboratory copybooks. As well as acknowledging and affirming students' achievement in practical work, science departments should consider extending the range of approaches used in assessing students' performance in this area.

Students kept records of practical work, generally in special notebooks. In a number of schools there was a variation in the quality and assessment of these records. Where there was good practice in the monitoring of students' practical notebooks, teachers gave formative assessment through affirmative and constructive comments. This written feedback facilitated students in improving their report-writing.

Regrettably, however, the inspectors noted that teachers in many schools did not follow up feedback that they had given to students. In these instances, for example, students' practical notebooks lacked some experimental results,

contained unlabelled graphs or diagrams, or included incomplete procedures, despite the teachers' requests to complete the work. The inspectors recommended that teachers place a stronger emphasis on the monitoring and follow-up of students' records of practical work.

Features of good practice

- Students' practical work is included in end-of-term examinations
- There is formative assessment of students' practical work

Concerns

- Teachers are not following up on feedback given to students on their practical work

5.3 Homework

There was a strong emphasis in the majority of schools on the assignment and correction of homework in Science. In most lessons visited, homework was regularly assigned, and the majority of students displayed a good attitude to it. Students' copybooks in these lessons were generally very well maintained and contained a significant amount of work. In some instances there was a high level of attention to the monitoring of homework, and excellent written feedback was given. Good practice was noted where homework was appropriately differentiated according to students' abilities and needs. In schools where a whole-school homework policy had been formulated this policy was sometimes included in the science plan.

> Most classes began with homework being corrected and finished with [the] assignment of homework for the next lesson. This approach lends structure to the lesson and students are encouraged to note homework assignments in their journals. Form tutors monitor these journals and parents are asked to check and sign them periodically. This level of supervision is commendable practice.

Samples of students' homework viewed during inspections showed that there were variations in the standards of presentation and in the quantity of homework completed. In some instances it was noted that students experienced

difficulty with their spelling and writing. The inspectors reported that written homework needed to be monitored and annotated more frequently in some schools.

The inspectors also noted the importance of teachers identifying students who had difficulties and establishing appropriate strategies for assisting them. The link between assessment and homework should be developed so as to encourage and reward students' efforts in completing, correcting and learning from homework. Science departments should consider adopting common practices for the monitoring and evaluation of homework that would include an increased use of formative, comment-based feedback that identifies for students what is required for improvement.

Features of good practice

- A high level of attention is given by teachers to the monitoring of homework and the provision of written feedback to students

Concerns

- Written homework is not monitored frequently in some schools

Chapter 6

Summary of main findings and recommendations

The quality of subject provision and whole-school support

Main findings

Science was a core subject in most schools; and in schools where Science is optional its uptake was generally very high.

Science classes in most schools were of a size that is suitable for student-centred laboratory work.

Schools generally were very supportive of the continuing professional development needs of science teachers.

Adequate provision for Science and very good facilities for the teaching and learning of Science existed in many schools.

The majority of school laboratories were well maintained.

In many schools the learning environment was enhanced by displays of scientific posters and students' projects.

A good level of ICT facilities was available in many science departments.

A high level of attention to ensuring a safe working environment was evident in many science departments.

Recommendations

Access to Science should not be based on students' abilities.

Schools should have a laboratory timetable, so that all students have access to laboratories.

Schools should manage their science resources in accordance with best safety practice and Department recommendations.

Schools should facilitate science departments in planning for the use of ICT in the teaching and learning of Science.

Schools are encouraged to make greater use of the support services for training on teaching and learning in mixed-ability settings.

Schools should continuously update their health and safety statements, in consultation with science teachers.

The quality of planning and preparation: whole-school planning

Main findings

There was very good teamwork in the majority of science departments, and many schools had devised common programmes of work.

The extent and quality of planning by individual teachers and by science departments was increasing.

Teachers' record-keeping was generally very good.

Recommendations

While an increasing number of schools have appointed a science co-ordinator, there is a need for a greater level of co-ordination of their work by science departments.

Each school should have a science department plan that describes the school's provision for Science.

The quality of planning and preparation: individual teachers' planning

Main findings

Planning for the lessons observed was generally very good, including the setting of aims, objectives, and desired lesson outcomes.

In a small number of schools planning was taking place only at the level of individual teachers.

Recommendations

Individual teachers' planning should take place in the context of a comprehensive subject plan for Science, which is developed collaboratively by the teachers in the science department in the school.

The quality of teaching and learning

Main findings

ICT was increasingly and effectively used in teaching and learning in many schools.

There was a good working atmosphere in the great majority of schools, with generally very high participation levels by students in lessons.

The atmosphere in many lessons was supportive, with students receiving individual attention and positive reinforcement.

Science was made relevant to students and linked to everyday experiences in many lessons.

Practical laboratory activities were effectively organised in most schools.

In some schools, students were not learning about Science in an investigative way, as required by the syllabus.

Differentiated teaching methods were used in many schools.

Recommendations

Support services should include the skills of differentiated teaching in their programmes.

Teachers in many schools should review the way in which they use the textbook in science classes. Reading the textbook should not take up considerable proportions of class time; rather the textbook should be used to supplement and reinforce learning and teaching already completed during the lesson.

The investigative approach to Science, as required by the syllabus, must be adopted in all schools.

The development of students' skills in report-writing should be systematically addressed in the teaching and learning of Science.

There should be close co-operation between science and learning-support departments to meet the needs of students with special educational needs.

Greater use by schools of the resources of the Special Education Support Service is recommended so as to best accommodate the learning needs of students with special educational needs.

Students' achievement and learning

Main findings

In most of the lessons observed, most students were learning.

Where teachers set high expectations of work and behaviour, students were generally focused on the task and were learning.

In most instances, students' work examined showed an appropriate level of development of skills and knowledge in Science.

In practical lessons, students displayed confidence and competence in the completion of their assigned tasks.

Recommendation

Schools should monitor the uptake of higher-level and ordinary-level Science to ensure that students are challenged to study Science at the most appropriate level.

The quality of assessment

Main findings

Collaboration among teachers of Science was evident in many schools that had common school assessments for each year group.

Many schools included the assessment of students' performance of practical work in the marks for school examinations.

There was a strong emphasis in the majority of schools on the assignment and correction of science homework.

In some schools teachers gave students feedback by commenting on their work.

Recommendations

Students should receive formative, comment-based feedback on their work from Science teachers.

The assessment of practical work and laboratory notebooks should be incorporated in end-of-term examinations.

Students' laboratory notebooks should be monitored regularly.

Science departments should have common practices for the monitoring and evaluation of homework.

Teachers should concentrate on raising students' expectations and should encourage them to take Science at higher level in the Junior Certificate examination.

Schools should extend the practice of having common school assessments for each year group.

Appendix

References

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Department of Education and Science (2007). *Junior Certificate Science: Guidelines for Teachers.* Dublin: Stationery Office.

Department of Education and Science and State Claims Agency (2005). *Review of Occupational Health and Safety in the Technologies in Post-primary Schools*. Dublin: Stationery Office.

Inspectorate (2004). *A Guide to Subject Inspection at Second Level.* Dublin: Department of Education and Science.

State Examinations Commission (2007). *Chief Examiner's Report on 2006 Junior Certificate Examination in Science.* Athlone: State Examinations Commission.

Useful web sites

General education web sites

www.education.gov.ie	Department of Education and Science
www.ncca.ie	National Council for Curriculum and Assessment
www.ncte.ie	National Centre for Technology in Education
www.examinations.ie	State Examinations Commission
www.sdpi.ie	School Development Planning Initiative (See "Resource material")
www.slss.ie	Second Level Support Service
www.scoilnet.ie	Scoilnet (NCTE schools web site)

Web sites for teaching and learning in Science

www.juniorscience.ie	Junior Science Support Service
www.science.ie	Discover Science and Engineering
skoool.ie	Web site for schools
www.physics.slss.ie	Physics Support Service
www.chemistry.slss.ie	Chemistry Support Service
www.biology.slss.ie	Biology Support Service
www.ista.ie	Irish Science Teachers' Association
www.ase.org.uk	The Association for Science Education (UK)
www.nsta.org	National Science Teachers Association (USA)
www.rsc.org	Royal Society of Chemistry (RSC)
www.iop.org	Institute of Physics
www.hsa.ie	Health and Safety Authority (HSA)