Implementing the Revised Junior Certificate Science Syllabus

What Teachers Said

Eemer Eivers
Gerry Shiel
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Prepared for the Department of Education and Science by the Educational Research Centre

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Preface

Teachers of Junior Certificate science classes were surveyed in conjunction with the administration of the Programme for International Student Assessment (PISA). Students were assessed between late March and early April 2006, while teachers completed questionnaires between March and May. A detailed report on the survey and its findings is available on *www.erc.ie/documents/pisa06sciencetq.pdf*.

The present report, which is designed for a general audience, summarises key findings and recommendations from the research. It is divided into eight chapters. Chapter 1 provides some background to the study and outlines how teachers were selected to take part. Chapter 2 describes the characteristics of the teachers surveyed, including qualifications and teaching experience, while Chapter 3 describes their experiences of in-career development (ICD). In Chapter 4, classroom teaching practices are outlined. In Chapter 5, some links are made with the PISA framework for scientific literacy. Chapter 6 describes teacher responses to questions about the revised Junior Certificate Science Syllabus (rJCSS), while Chapter 7 summarises a series of additional comments written by teachers about the syllabus. Finally, in Chapter 8, some conclusions and recommendations arising from the survey are outlined.

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List of Acronyms

ASTI	Association of Secondary Teachers Ireland
ICD	In-Career Development
ICT	Information and Communication Technologies
OECD	Organisation for Economic Co-operation and Development
PISA	Programme for International Student Assessment
rJCSS	Revised Junior Certificate Science Syllabus
TIMSS	Third International Mathematics and Science Study

1 Background

This report examines the teaching of science to Junior Certificate students in post-primary schools in Ireland. It is based on responses to a questionnaire completed between March and May 2006 by science teachers in schools participating in the third cycle of the Programme for International Student Assessment (also known by the acronym 'PISA', and described in the next section) in 2006.

The main purposes of the survey were to:

- describe the backgrounds of teachers of Junior Certificate science;
- examine teachers' views on the revised Junior Certificate Science Syllabus (rJCSS);
- examine linkages between the PISA science framework and science teaching in Irish schools.

A more detailed description of the study, including greater detail on sampling methods, weights, background information and results, is available at *www.erc.ie/documents/pisa06sciencetq.pdf*.

PISA: An Overview

The OECD's Programme for International Student Assessment (PISA) is an assessment of 15-year-olds' knowledge and skills (referred to as 'literacy') in the areas of reading, mathematics and science. Fifteen-year-olds were chosen as the target group for the study because, at this age, compulsory schooling ends in many countries. Thus, PISA attempts to assess how well students are equipped to face the reading, mathematical and scientific demands of future adult life.

Some of the main features of PISA are summarised below.

- PISA is a paper-and-pencil assessment, containing a mixture of multiple-choice items and items where students need to write their own answers. Sometimes only a very short answer is required; sometimes a more in-depth response is needed.
- As well as test booklets, questionnaires are given to students and to principals. This allows an examination of how student achievement relates to different student and school background characteristics.
- Test and questionnaire items are jointly developed by participating countries.
- Over 250,000 students in 41 countries took part in PISA in 2003. In 2006, student numbers will be even bigger as 55 countries took part in the assessment.

PISA takes place in 3-year cycles, and each cycle looks at one of the three skills areas in depth, while also assessing the other two areas. In the 2006 cycle, science was the focus of the assessment. Scientific literacy is defined as an individual's:

- scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues;
- understanding of the characteristic features of science as a form of human knowledge and enquiry;
- awareness of how science and technology shape our material, intellectual, and cultural environments; and
- willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen.

Each cycle of PISA is guided by an assessment framework, which defines the areas to be assessed. These detailed definitions inform the development of test items, including the types of item used and the topics covered. The framework upon which the 2006 cycle is based can be downloaded from *http://www.pisa.oecd.org/*. The framework includes sample test items and responses. Although the international element of PISA did not include a science teacher questionnaire, such a questionnaire was developed and administered in Ireland as part of PISA 2006.

How Teachers Were Selected

A random selection of 165 mainstream post-primary schools (all with 15-year-old students enrolled) was invited to participate in PISA 2006. All selected schools agreed to participate. Because the questionnaire was administered as part of PISA, only those teaching in these 165 schools were surveyed. Questionnaire distribution was further restricted to those who were teaching Junior Cycle science classes at the time of the survey. In total, there were 735 such teachers. Of these, 688 teachers from 163 schools returned completed questionnaires - a response rate of 93.6%. Given that all selected schools participated and that there was a very high response rate from teachers, the views expressed by those who completed questionnaires may be taken as representative of those teaching Junior Certificate science in Irish schools.

Why Science Teachers Were Surveyed

There are three main reasons why science teachers were surveyed in conjunction with PISA in Ireland. First, current data provided by the Department of Education and Science (Statistics Section, personal communication) and the Higher Education Authority (2006) indicate a slight increase in uptake of science at second and third level. However, there remains a common perception of a science 'crisis' in Ireland. Thus, current information about the teaching of science in post-primary schools would seem useful. Second, most teachers were implementing a revised syllabus which was being examined for the first time in 2006. Thus, teacher views on the theory and the implementation of the syllabus provide useful and highly relevant information. Third, examining links between the syllabus, classroom practice, and PISA's idea of 'scientific literacy' could help us to understand Irish students' performance on the PISA science test, when results are released by the OECD.

The revised Junior Certificate Science Syllabus (rJCSS) differs from its predecessor in a number of ways. Greater emphasis is placed on student investigation and practical work, designed to help students develop an understanding of science concepts, as well as acquire the necessary science process skills. For the first time, 35% of a student's marks in the Junior Certificate science examination are based on their performance on two practical elements of the course - Coursework A (10% of total marks), and Coursework B (25% of total marks). Coursework A involves the completion and writing up of 30 specified[1] practical activities, while Coursework B requires students to carry out two scientific investigations from three topics provided by the State Examinations Commission, or a single investigation of their own choosing (subject to meeting certain criteria).

The rJCSS is designed to be outcomes-based, rather than content-based. In practical terms, this means that the focus has shifted from a list of prescribed topics to what students should be able to do. It also places more emphasis than the older syllabus on a science-technology-society (STS) approach, where scientific facts are linked to everyday life, thus assisting student understanding of science. One of the reasons for this was to create a better match between primary and post-primary syllabi (primary pupils study science under the general curriculum area of Social, Environmental and Scientific Education, which is also based on an STS approach).

Another aim of the rJCSS is to increase interest in science amongst students, thereby increasing the uptake of science subjects at Leaving Certificate and at third level, as well as promoting students' long-term engagement in the scientific society in which they live. In this regard, it reflects some of the recommendations of the Report of the Task Force on the Physical Sciences (2002). One of the main concerns of the Task Force was the low uptake of physics and chemistry at Senior Cycle. This concern is reflected in the restructuring of the rJCSS to ensure a better balance between the three core science subjects. Students no longer choose from a number of optional topics, as this was perceived to favour biology. The mandatory practical activities in Coursework A are divided evenly between the three core subjects, and the terminal examination paper consists of three compulsory sections, covering biology, chemistry and physics. These changes are expected to encourage Senior Cycle uptake of physics and chemistry. Finally, although not specific to the rJCSS, there has been a move towards greater integration of Information and Communication Technologies (ICT) into classroom practice. In relation to science lessons, this is reflected in the increased use of technologies such as datalogging.

[1] These are generally referred to as the *mandatory* activities. In fact, students are expected to conduct all practical activities included in the syllabus, not just those specified in Coursework A. However, the 30 activities specified in Coursework A must not only be completed, but written up for assessment purposes.

In many ways, the changes have improved the alignment between the Junior Certificate Science Syllabus and PISA, in terms of moving closer to the concept of scientific literacy as defined by the PISA assessment framework. In fact, the definition of scientific literacy used for the PISA 2000 assessment (OECD, 2000) was cited as part of the rationale for a syllabus revision (Department of Education and Science, 2003, p. 3). Thus, the rJCSS and the PISA views of science recognise the importance of the capacity to use scientific knowledge, of understanding how science can shape our environment, and of using science to draw evidence-based conclusions and make decisions.

Further, the focus in the revised syllabus on conceptual understanding and the development of practical and investigative skills within an STS context is reflected in the three main aspects of the PISA science framework - scientific knowledge, scientific processes, and scientific areas of applications.

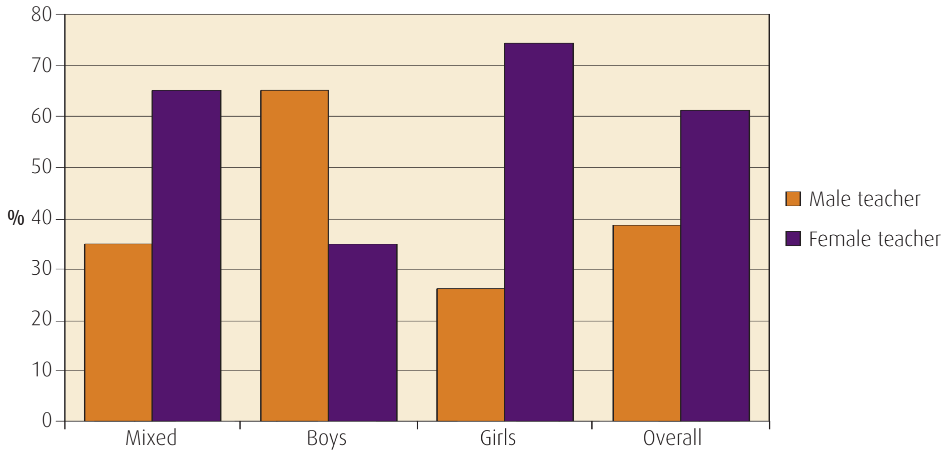
It remains to be seen how the changes envisaged in the rJCSS (to have student-centred lessons, with a real-life focus) and in the curriculum more generally (greater use of ICT) are reflected in practice. For example, an ASTI (2006) survey reported a perceived increase in teacher workload, a perception that might hamper the use of the investigative approach. Further, in an OECD (2004) survey of 14 countries in 2001, Ireland ranked last in teacher usage of ICT, suggesting that it will take time before ICT becomes an integral part of science lessons. Finally, the cross-national TIMSS study in 1995 found that Irish science teachers were less likely than teachers in most countries to believe that understanding how science is used in the real world is very important for success in science (Beaton et al., 1996).

For reasons such as these, it is important to garner teacher views on the revised syllabus, and to establish how well the syllabus as a theoretical construct is reflected in practice. This, in turn, will help us to interpret Irish students' performance on the PISA science scales, when published.

2 Teacher Characteristics

Sixty percent of respondents worked in secondary schools, 24% worked in vocational schools, and 16% in community or comprehensive schools, largely reflecting the national distribution of schools by sector. In single-sex boys' schools, most teachers were male, while most teachers were female in single-sex girls' schools and in mixed-sex schools (see Figure 2.1). Overall, 61% of teachers were female.

Figure 2.1: Percentage of male and female teachers, by school sex type and overall



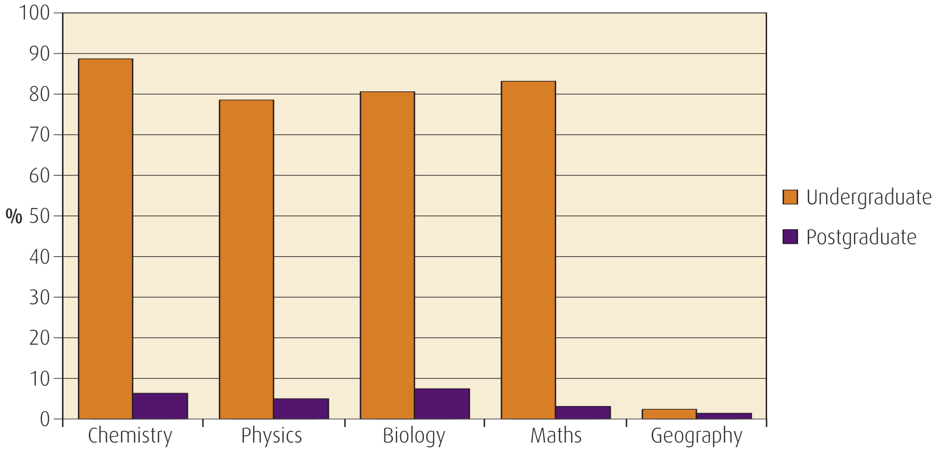
Most teachers surveyed were very experienced, averaging almost 17 years as a teacher. Just 4% were in their first year of teaching. Male teachers averaged 20 years experience, compared to 14 years amongst female teachers.

Qualifications

Almost all (96%) had completed an undergraduate degree in which science was a major or a minor component. Six percent had completed a postgraduate degree with science education as a major component, while 84% had completed a Higher Diploma in Education. However, the latter percentage is an underestimate of those with science teaching qualifications, as it does not take into account those whose undergraduate degree was in science education. The percentage with teaching qualifications is likely to be considerably higher.

Chemistry was the subject most commonly studied at undergraduate level (88% of respondents) while biology, physics and mathematics were each studied by over three-quarters of respondents (Figure 2.2). However, only a minority had studied any of these at postgraduate level. At 7%, biology was the most popular subject at postgraduate level, while, at 3%, mathematics had the lowest percentage taking the subject. Two percent of respondents had studied geography at undergraduate level, as had just under 2% at postgraduate level.

Figure 2.2: Percentages of teachers who studied science, mathematics or geography at undergraduate and postgraduate levels

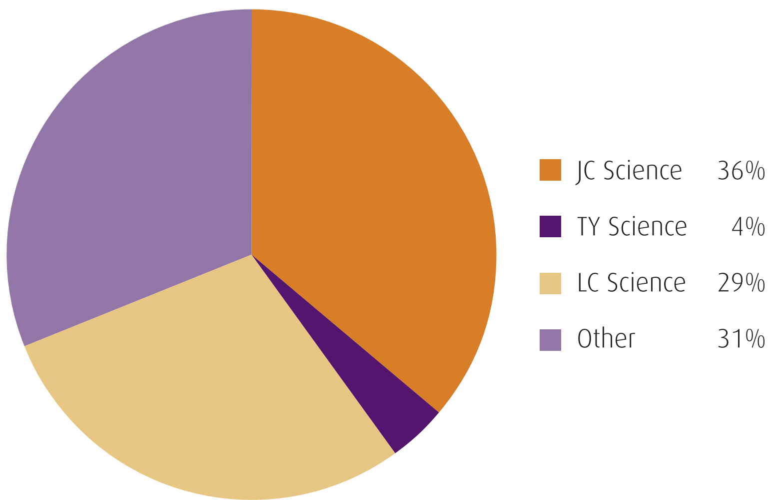


Overall, subject uptake rates were similar for males and females. However, while 88% of female teachers had studied biology as undergraduates, only 67% of males had done so. Conversely, 84% of males had studied undergraduate physics, compared to 75% of females.

Class Contact Hours

Teachers were asked about the division of their teaching load at the time of the survey. Respondents averaged just over 20 teaching hours per week. Approximately one-third of this time was spent teaching Junior Cycle science classes, with 29% of time given to Leaving Certificate science classes (Figure 2.3). On average, only 4% of class contact time was spent teaching Transition Year science, while almost one-third of time was spent teaching non-science subjects (including mathematics and geography).

Figure 2.3: Average percentage of class contact hours spent teaching various subjects



3 In-Career Development

The Junior Science Support Service - set up to support teachers in implementing the rJCSS - invited schools to take part in an in-career development (ICD) programme which included six one-day seminars over the first three years of the syllabus implementation. Amongst the teachers surveyed, the average number of such seminars attended was just under four and a half. While 45% had attended all six seminars offered, 7% had not attended any. Most of this latter group were not newly qualified teachers (in other words, they did not miss the ICD because they were still in college), and they were teaching the revised syllabus. Thus, a small, but significant minority of teachers were teaching a science syllabus for which they had not received specific training. Respondents had also attended an average of 2.3 days related to other aspects of science teaching, although 45% had not attended any ICD related to other aspects of teaching science.

Views on ICD

Of those who had attended ICD related to the revised syllabus, most were satisfied with various elements of the seminars (Table 3.1). Over 80% were satisfied or very satisfied with the usefulness of the handouts and CDs provided on the courses, and with the frequency of the seminars. At least three-quarters were satisfied or very satisfied with the explanation of new teaching methodologies, the quality of the course content, and the usefulness of the Support Service's website (*www.juniorscience.ie*). However, 13% indicated that they did not know how useful the *juniorscience.ie* website was, suggesting that they had never used it. Satisfaction was much lower with the information provided on assessment procedures, with 55% indicating they were dissatisfied or very dissatisfied.

Table 3.1: Percentage of teachers reporting various levels of satisfaction with elements of ICD related to the revised syllabus

	N	Very satisfied	Satisfied	Dissatisfied	Very dissatisfied	Don't know
CDs	612	32.1	57.4	9.3	1.1	
Juniorscience.ie website	619	20.0	58.9	6.7	1.0	13.4
Handouts	613	18.8	65.9	14.3	1.1	
Seminar frequency	622	18.4	65.5	15.0	1.1	
Explanation of new teaching methodologies	620	12.7	62.8	21.2	3.4	
Quality of course content	613	12.7	65.4	18.9	3.0	
Information on assessment procedures	617	6.6	38.5	40.2	14.7	

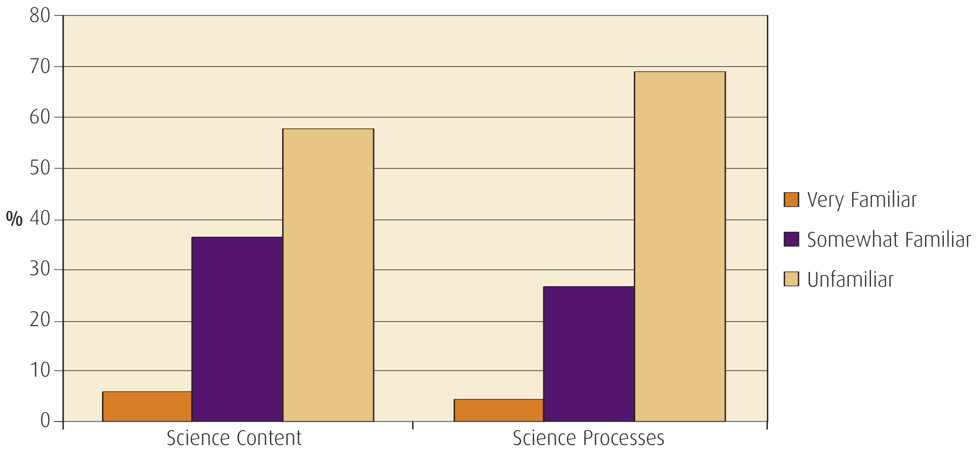
Teachers were asked which, if any, additional topics related to the revised syllabus they would like addressed in ICD. The most common type of topic related to general issues about the practical and coursework elements of the syllabus, mentioned by 13% of all respondents. Typical comments included 'how to proceed with Coursework B', 'hands-on with Coursework B', and 'practical work procedures'. Although many of the suggestions in this category were quite vague, the frequency with which Coursework B was mentioned suggests an information gap that has not been filled by ICD. A further 5% wanted ICD dealing with the assessment of Coursework, with most referring specifically to Coursework B.

Seven percent of teachers wanted ICD on teaching methods and materials. In particular, science teaching methodologies for mixed ability classes or weaker classes were mentioned, as were datalogging, the use of Information and Communication Technologies, and hands-on training in the use of teaching software. Other topics mentioned included specific syllabus topics (e.g., electronics/electricity), marking schemes and guides, laboratory safety training, and advice on how best to prepare laboratories for lessons.

Familiarity with the Primary School Science Curriculum

The development of a smoother linkage between the primary and post-primary science curricula was one of the reasons behind the revision of the Junior Certificate Science Syllabus. Consequently, a session dealing with the primary school science curriculum was included as part of the initial ICD on the rJCSS. Despite this, teachers' responses indicate a relatively poor knowledge of aspects of the primary science curriculum. Teachers were asked to indicate their familiarity with the current curriculum in science for Fifth and Sixth class, in terms of science content and science processes. A small minority (less than 6%) were very familiar with the science content or processes of the curriculum for these classes (Figure 3.1). Fifty-eight percent reported that they were unfamiliar with the science content, while 69% described themselves as unfamiliar with science processes in the Primary School Curriculum.

Figure 3.1: Percentage of science teachers reporting various levels of familiarity with aspects of the Primary School Curriculum in science for Fifth and Sixth classes



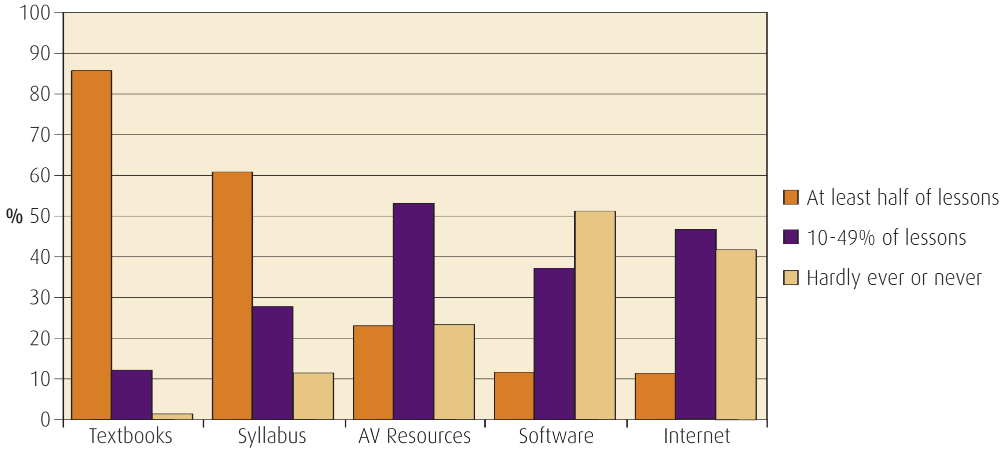
4 Classroom Teaching Practices

All teachers were asked a number of questions about typical classroom teaching practices, including lesson planning, activities carried out in lessons, and factors perceived to be obstacles to teaching science.

Lesson Planning

The resources most commonly used to plan Junior Certificate science lessons were student textbooks, used by 86% of teachers to plan at least half of lessons, with only 2% indicating that they hardly ever or never used them to plan lessons (Figure 4.1). The next most commonly used resource was the science syllabus, used by 61% of teachers to plan at least half of their Junior Certificate science lessons. Audio-visual resources were also widely used, with 23% of teachers using them to plan at least half of lessons. In contrast, 42% hardly ever or never used information from the Internet in lesson planning, while just over half of teachers hardly ever or never used content-based software.

Figure 4.1: Percentages of teachers indicating how often they used various resources to plan science lessons

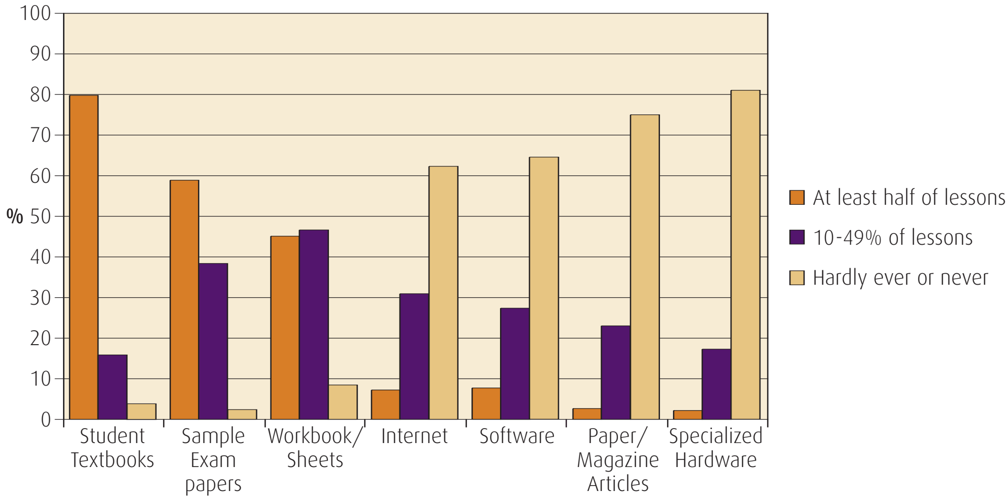


Those teaching the older syllabus were less likely to use the Internet to plan lessons (54% hardly ever or never did so, compared to 40% of those teaching the rJCSS). They were also less likely to use content-based software to plan lessons (74% hardly ever or never did so, compared to 48% of those teaching the rJCSS). However, as the numbers teaching the pre-2003 syllabus were very small, findings must be interpreted with caution.

Classroom Resources

As with planning lessons, the resources most commonly used with Third Year[2] science classes were student textbooks - used in at least half of lessons by 80% of teachers (Figure 4.2). Fifty-nine percent of teachers also reported using past or sample exam papers in at least half of science lessons with Third Year students, while 45% used workbooks and worksheets in at least half of lessons. The resources least frequently used were specialised hardware (such as datalogger), and newspaper or magazine articles about science - hardly ever or never used by at least three-quarters of Third Year science teachers. Over 60% also reported that they hardly ever or never used information from the Internet or content-based software in Third Year science lessons.

Figure 4.2: Percentages of teachers indicating how often they used various resources in Third Year science lessons



There were few differences in the responses of those teaching the older and the revised syllabi. However, while 45% of those teaching the revised syllabus in Third Year used workbooks or worksheets in at least half of lessons, only 30% of those teaching the older syllabus did.

Class Activities

Teachers were asked how frequently they or their students engaged in certain activities during Third Year science lessons. Most teachers reported that, in at least half of lessons, students performed experiments by following instructions, and drew conclusions from experiments (Table 4.1). However, students designing an experiment to answer a scientific question, or reading articles about science in sources other than their usual textbooks, were far less common. Indeed, 72% of teachers indicated that students hardly ever or never read articles about science in sources other than their textbooks.

[2] As the classroom resources used can vary by grade level, questions relating to resource usage were limited to Third Year classes.

Somewhat unexpectedly, given the focus on Coursework in the rJCSS, 5% of those teaching the rJCSS to Third Year students (6% of all teachers) reported that their Third Year students hardly ever or never did experiments by following instructions. Also, 2% (3% of all teachers) reported that students hardly ever or never spent time in a lab doing practical experiments.

Seventy-eight percent of teachers reported that they related scientific concepts to real-world examples in at least half of lessons. Other activities frequently engaged in by most teachers included using a physical model to help students understand a science topic, and using examples of technological application to show how science is relevant to society. Teachers were least likely to report regularly doing experiments as a demonstration. Nonetheless, one-quarter of teachers said that they did so in at least half of lessons with Third Year students.

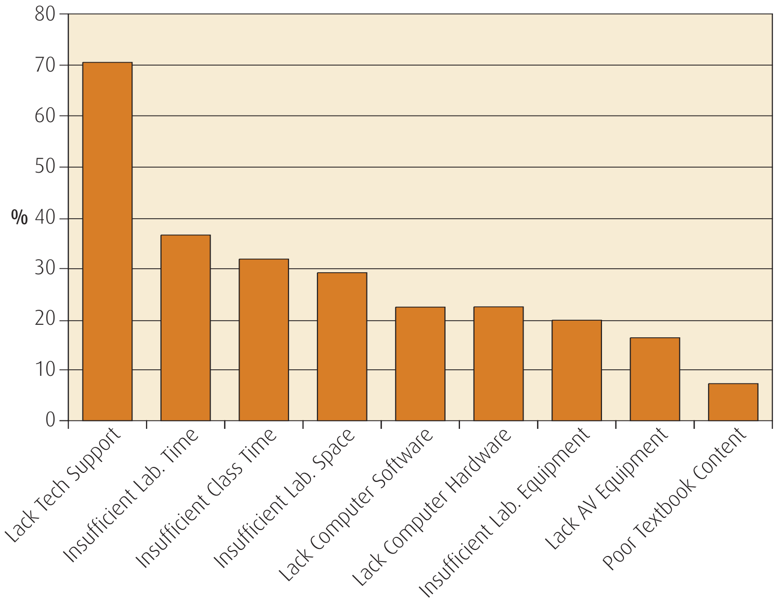
Table 4.1: Percentages of teachers indicating how often listed activities occurred in their Third Year science lessons

Students . . .	N	At least half of lessons	10-49% of lessons	Hardly ever or never
draw conclusions from an experiment they have conducted	563	65.0	29.8	5.3
do experiments by following instructions	561	56.0	37.8	6.2
spend time in a lab doing practical experiments	561	47.2	49.6	3.2
design an experiment to answer a scientific question	560	9.7	43.5	46.8
read articles about science in sources other than their usual textbooks	557	3.7	24.4	71.9
The teacher . . .	**N**	**At least half of lessons**	**10-49% of lessons**	**Hardly ever or never**
relates scientific concepts to examples in the real world	564	78.0	21.7	0.3
uses a physical model to help students understand a science topic	560	41.6	46.9	11.5
uses examples of technological application to show how science is relevant to society	559	40.0	43.6	16.4
does experiments as demonstrations	558	24.4	55.4	20.2

Obstacles to Effective Teaching

Those teaching Third Year students were asked to indicate the extent (if any) to which a variety of factors impeded their effectiveness in teaching science. As can be seen from Figure 4.3, lack of technical support was far more likely than any other factor to be described as greatly impeding teaching. Seventy-one percent of teachers felt that lack of technical support (e.g., a laboratory assistant) impeded their teaching of science to Third Year students to a great extent. Approximately one-third cited insufficient class time, insufficient laboratory time, and/or insufficient laboratory space as great impediments. Factors such as lack of computer software, lack of computer hardware, insufficient laboratory equipment and lack of audio-visual equipment were also described as great impediments to teaching by a sizeable minority of teachers. Only 7% described poor quality textbooks as impeding their teaching to a great extent, although 37% indicated that it was somewhat of an impediment.

Figure 4.3: Percentages of teachers indicating the extent to which a variety of factors greatly impeded their teaching of science to Third Year students



To support the introduction of the rJCSS, schools were provided with a grant of €3,500 for each Junior Cycle science laboratory in the school. In addition, schools which had not had a major capital upgrading since 1995 could apply for an enhanced grant to meet identified needs. On average, schools received a total grant of approximately €18,000. Given this, it is not surprising that those teaching the rJCSS were less likely than those teaching the older syllabus to feel impeded by lack of laboratory equipment. Fifty-two percent of those teaching the rJCSS felt that insufficient laboratory equipment impeded their effectiveness (either to a great, or to some extent), compared to 68% of those teaching the pre-2003 syllabus. However, those teaching the rJCSS were more likely to cite a lack of computer software (50% said that lack of software was, at least to some extent, impeding their effectiveness, compared to 38% of those teaching the older syllabus).

5 Links with PISA Science Framework

As noted in Chapter 1, one of the reasons for surveying science teachers was to examine links between the rJCSS, classroom practice, and PISA's conceptualisation of 'scientific literacy'. An important aim of PISA is to assess the extent to which students are prepared for future learning and for life after school. Consequently, teachers were asked to state, in their opinion, how well the rJCSS prepared students for a number of aspects of the world outside school. Overall, views were reasonably positive. Almost all felt that it equipped students with the skills to understand scientific phenomena encountered in everyday life, either to a great extent or to some extent (Table 5.1). Over 80% of respondents felt that the revised syllabus (at least to some extent) helped students to understand how science is used in the real world, to develop a curiosity about science, and to develop a positive attitude about science.

However, teachers were less positive about how the rJCSS equipped students to critically read a newspaper or magazine article about a scientific experiment. Almost two-thirds of teachers (62%) felt that the rJCSS did very little or nothing to help students do so.

Table 5.1: Percentages of teachers indicating how well the rJCSS equips students with scientific knowledge/skills they will need for their future lives

	N	To a great extent	To some extent	Very little	Not at all
Understanding scientific phenomena encountered in everyday life	661	11.7	79.0	8.6	0.7
Understanding how science is used in the real world	659	14.0	71.5	14.0	0.6
Developing a positive attitude about science	662	12.9	71.0	14.5	1.5
Developing a curiosity about science	661	12.1	69.0	17.1	1.8
Critically reading a newspaper/magazine article about a scientific experiment	661	3.7	33.9	51.7	10.7

Teachers were asked to indicate how much emphasis they placed on developing particular skills in their Third Year science students. The skills chosen were those identified in the PISA science framework as important life skills. Forty percent reported placing a lot of emphasis on interpreting scientific evidence and drawing conclusions, and on explaining conclusions reached and the scientific evidence on which they are based (Table 5.2). Indeed, only 3% indicated that they placed no emphasis on developing these skills. One-third placed a lot of emphasis on teaching students to apply scientific knowledge to a situation, with only 2% indicating that they placed no emphasis on developing students' skills in this area.

Over 70% of respondents also placed either some or a lot of emphasis on justifying the acceptance or rejection of conclusions, and on developing their students' skills in describing and explaining scientific phenomena and predicting changes. Most teachers also placed at least some emphasis on identifying suitable keywords to search for scientific information on a given topic, on distinguishing between scientific and non-scientific explanations, and on distinguishing between questions that can be answered using a scientific approach and those that cannot. However, roughly one in six teachers reported placing no emphasis on helping students to distinguish between questions that can and cannot be answered using a scientific approach.

Table 5.2: Percentages of teachers indicating how much emphasis they place on developing particular skills in their Third Year science students

	N	A lot	Some	A little	None
Interpreting scientific evidence and drawing conclusions	593	40.4	46.0	10.6	3.0
Explaining conclusions and the scientific evidence on which they are based	592	40.2	43.1	13.2	3.5
Applying scientific knowledge to a given situation	593	32.8	50.9	14.1	2.3
Describing or explaining scientific phenomena and predicting changes	586	28.4	50.5	17.4	3.7
Justifying the acceptance or rejection of conclusions	591	23.8	48.6	20.9	6.7
Identifying suitable keywords to search for scientific information on a given topic	590	21.2	43.2	24.3	11.4
Distinguishing between scientific and non-scientific explanations	589	17.7	40.4	31.0	11.0
Distinguishing between questions that can / cannot be answered using a scientific approach	590	10.8	44.9	27.3	17.1

6 Teachers' Views on the rJCSS

Respondents were asked for their views on the rJCSS, including their opinions of the syllabus content, the allocation of marks, how the Junior and Senior Cycle science programmes linked, and changes (if any) observed in classroom activities since the introduction of the revised syllabus.

They were also asked which science syllabus they were using with students sitting the Junior Certificate science examination in 2006. Most (73%) said the revised (2003) syllabus; 19% reported that they did not have an examination class in 2006, and 8% said they were implementing the old syllabus. Where there are notable differences between the views of those who had or had not taught the syllabus to an examination class, these are highlighted. However, given the small number in the latter category, data must be interpreted with caution.

Syllabus Content and Approach

Teachers were asked how satisfied they were with elements of the revised syllabus. With the exception of Coursework B, overall satisfaction levels were reasonably high (Table 6.1). For example, approximately three-quarters of teachers were either satisfied or very satisfied with Coursework A, with the practical work element in general, and with the investigative approach to teaching. Satisfaction was even higher for the range of topics in the rJCSS, with 88% indicating satisfaction. However, only 60% were satisfied or very satisfied with Coursework B. Indeed, one in ten teachers indicated that they were very dissatisfied with this element of the syllabus.

Table 6.1: Percentages of teachers indicating various satisfaction levels with aspects of the rJCSS

	N	Very Satisfied	Satisfied	Dissatisfied	Very dissatisfied
Mandatory activities (Coursework A)	487	20.8	53.3	22.6	3.2
Range of science topics (content)	489	16.6	72.1	10.2	1.0
Investigative approach to teaching science	484	17.0	62.9	16.8	3.3
Practical work in general	485	15.2	60.9	20.2	3.6
Investigations (Coursework B)	485	13.0	45.7	30.7	10.5

Table excludes responses from those not teaching the rJCSS to Third Year students.

Allocation of Marks

A major difference between the rJCSS and its predecessor is the allocation of marks to practical work and investigations. Currently, 65% of Junior Certificate science marks are allocated to the written examination, compared to 100% in the pre-2003 syllabus. Respondents were asked what percentage they felt should be allocated to the written examination. The average percent allocated was 67%, with just over half indicating that between 60% and 70% was appropriate (Table 6.2). A very small minority (3%) felt that 100% of marks should be allocated to the written examination.

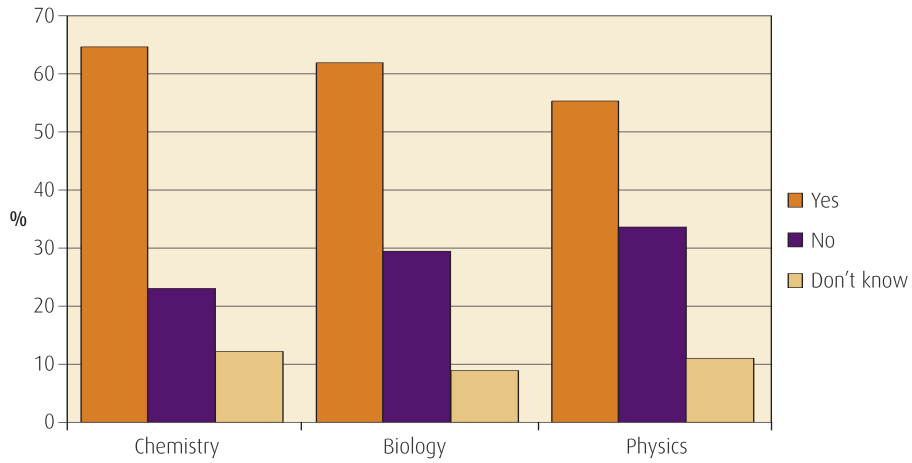
Table 6.2: Percentages of teachers indicating what percentage of Junior Certificate science marks should be allocated to the written examination

(N=625)	%
Up to 55%	17.5
60%	11.0
65% (current allocation)	30.7
70%	12.2
75%	10.3
76% - 99%	15.5
100%	2.7

Links with Senior Cycle Science

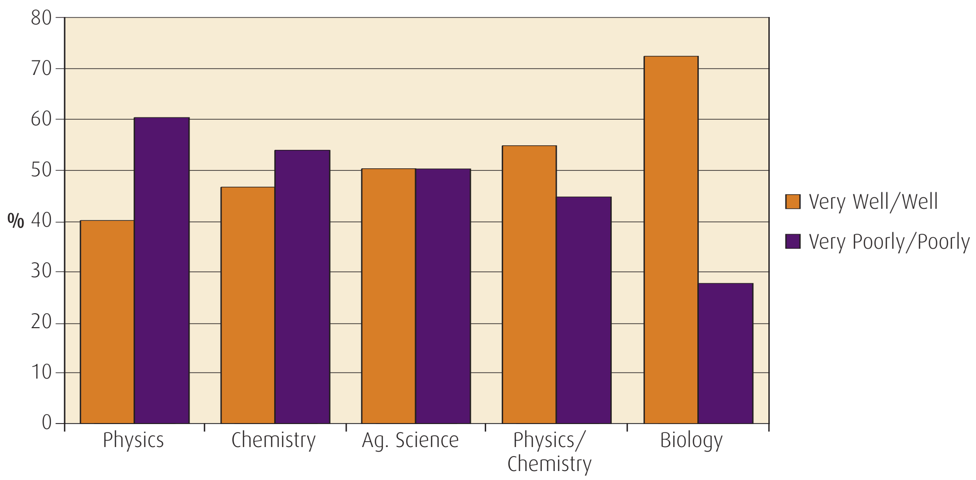
Teachers were asked if, based on their experience of the rJCSS, a practical component should be included in assessing Leaving Certificate science subjects. Figure 6.1 presents the responses, limited to those who had taught a given Leaving Certificate subject within the last three years. Two-thirds (65%) of those who had recently taught chemistry felt that a practical component should be included in assessing chemistry, while 12% did not know. A similar percentage (62%) of biology teachers felt a practical assessment element should be included for biology, but only 55% of physics teachers felt that physics should contain a practical assessment.

Figure 6.1: Percentages of teachers indicating if a practical assessment component should be taught in Leaving Certificate science subjects



Teachers were also asked how well they felt the rJCSS prepared students for Senior Cycle science courses. Examining only the responses of teachers who had recently taught the subject in question, greatest satisfaction was expressed with the extent to which students were prepared for Leaving Certificate biology (Figure 6.2). Seventy-two percent of teachers who taught Leaving Certificate biology felt that the rJCSS prepared students either well or very well for the Senior Cycle course. Over half (55%) of those teaching the physics and chemistry combined course indicated that students were well prepared for their course, as did half of those teaching agricultural science[3]. Satisfaction with the adequacy of preparation was slightly lower amongst chemistry teachers, and lowest of all amongst physics teachers. Only 40% of physics teachers felt that students were well or very well prepared for Leaving Certificate physics as a result of studying the rJCSS.

Figure 6.2: Percentages of teachers indicating how well they felt the rJCSS prepared students for Senior Cycle science courses



Changes in Classroom Practices

Respondents who had taught both the revised (2003) and earlier (1989) syllabus were asked to indicate the extent to which the revised syllabus resulted in changes in certain elements of their Third Year science lessons. Almost all felt that the amount of preparation required for science lessons had increased (Table 6.3). Eighty-seven percent felt that the revised syllabus had led to an increase in their use of an investigative approach to teaching science, while 41% noted an increase in their own use of ICT in lessons. Most, however, reported no change in the emphasis they placed on preparing students for the written Junior Certificate examination.

In terms of changes to student behaviour, over 80% felt that student engagement in practical work and use of investigative approaches had increased as a consequence of the revised syllabus, while most also felt that student collaborative group work had increased (Table 6.4). Sixty percent of teachers believed that the relevance of the syllabus content to students' everyday lives had increased, while half thought that the rJCSS had led to an increase in students' ability to apply scientific processes. However, over half felt that the

[3] As the numbers teaching these subjects are quite small, data need to be interpreted with caution.

rJCSS had not led to any change in students' interest in learning science, in their understanding of scientific concepts or in their use of ICT in science lessons.

Table 6.3: Percentages of teachers indicating the extent to which the rJCSS resulted in changes in certain elements of their behaviour in Third Year science lessons

	N	Major Increase	Some Increase	No change	Some Decrease	Major Decrease
Amount of work to prepare for science lessons	433	65.3	29.0	5.5	0.2	0.0
Use of investigative approaches to teach science	430	20.8	66.0	12.4	0.7	0.0
Use of ICTs in science lessons	432	7.8	33.5	56.9	1.2	0.5
Emphasis on preparing students for the written JC examination	433	4.7	14.7	52.9	23.7	4.0

Table 6.4: Percentages of teachers indicating the extent to which the rJCSS resulted in changes in Third Year students' experiences of science lessons

	N	Major Increase	Some Increase	No change	Some Decrease	Major Decrease
Involvement in practical work	433	42.7	43.3	13.6	0.5	0.0
Use of investigative approaches	429	24.3	62.7	13.0	0.0	0.0
Participation in collaborative group work/discussion	431	9.8	58.3	29.6	1.8	0.7
Interest in learning science	433	5.3	38.0	53.3	3.0	0.5
Relevance of content to everyday lives	429	5.3	55.4	35.9	3.2	0.1
Ability to apply science processes	431	4.3	47.3	42.7	4.8	0.9
Use of ICTs in science lessons	430	3.0	24.8	69.8	1.9	0.5
Understanding of science concepts	431	2.8	38.1	50.5	7.8	0.8

7 Additional Comments on the rJCSS

At the end of the questionnaire, teachers were asked if they wished to make any additional comments about issues raised in the questionnaire or about Junior Cycle science in general. An unusually large percentage (55%) did so, with approximately one quarter making comments on more than one theme or topic. The topics raised are summarised in Table 7.1, and described in more detail below.

Table 7.1: Summary of additional comments made by respondents

	N	% of all respondents	% of those who commented
Criticisms about syllabus content/style/depth	121	17.6	32.5
Need for a lab technician	110	15.9	29.4
Lack of time	97	14.2	26.2
Need for additional resources	60	8.7	16.1
Positive comment on syllabus content/style/ICD	56	8.2	15.1
Timing of Coursework B	54	7.9	14.5
How marks are obtained	50	7.3	13.6
Logistic/implementation problems with rJCSS	47	6.8	12.6
rJCSS and weaker students	34	4.9	9.0
Health & safety issues	11	1.7	3.1
Other	34	4.9	9.0

Percentages sum to more than 100% as some respondents made multiple comments.

Criticisms of Syllabus Content / Style / Depth

Almost one-third of those who added a comment (18% of all respondents) criticised the content, style or lack of clarity about the depth of the revised syllabus. Views were sometimes contradictory. For example, some felt that there should be fewer topics on the syllabus, with more in-depth coverage of those retained. However, others commented that while the approach adopted was generally positive, they felt that students were missing a foundation in some of the basics of science, suggesting that some important topics were missing.

Common complaints related to a lack of clarity about the depth with which topics needed to be covered and an over-emphasis on learning facts, with no time to examine concepts. Many raised specific issues related to the practical work element of the syllabus. For example, there was a perception that too much time had to be spent writing up experiments, while little attention was given to how well students actually carried out the experiments. Thus, some felt that writing skills, rather than the ability to conduct an experiment, were rewarded. A small number complained about the style of language used in the syllabus and textbooks, suggesting that it was difficult for weaker students to understand.

Others felt that there were too many mandatory activities, while a small number indicated that the mandatory activities selected were poor exemplars. Some complained that although there were officially 30 mandatory activities, in practice, many more activities had to be completed. Other complaints included the view that conducting and writing up the mandatory activities consumed all allocated class time, with the result that there was no time for discussion and analysis.

Other comments in this general category included perceived weaknesses in the coverage of particular areas (physics, chemistry and biology were all mentioned as 'losing out' in the revised syllabus), and the widening of the gap between the requirements of Junior Certificate and Leaving Certificate science subjects. Biology was mentioned as needing a more practical orientation in the rJCSS, while the (possible) lack of the need to learn definitions was seen as an obstacle to Leaving Certificate physics and chemistry.

"The information content of the course has been reduced, creating problems at Leaving Certificate. Better to shorten the syllabus and give more details"

"The revised syllabus is big on activities but short on science"

"The investigative approach is the way forward but you also need to create a foundation in the basics of science"

"I am also extremely concerned about how these students will cope with the even greater jump into L.C. physics than they had with the old course. The two don't seem to apply to each other"

"JCSS is <u>very good</u> on the process of doing science. JCSS is <u>seriously lacking</u> in important content, e.g., global ecological issues, knowledge of the universe"

"Most of the mandatory practicals are not discovery-based"

Laboratory Technicians

A large percentage (29% of those who offered a comment, or 16% of all respondents) raised the issue of laboratory technicians or assistants. Consequently, this topic is treated separately from the more general category of a perceived need for additional resources. There were no contradictory comments on this topic. All who raised the issue felt that laboratory technicians or assistants were needed to help teachers implement the syllabus properly. There was a consensus that the revised syllabus had greatly increased the amount of laboratory-based work required, without any concomitant reduction in contact teaching hours. Respondents felt that there had been an increase in laboratory-based lessons, and in the time needed to prepare laboratories for lessons, to clear up after lessons, and to engage in laboratory management and stock control. They felt that laboratory technicians were needed to help them manage some or all of these tasks, as well as assisting with supervision when a large number of students was conducting experiments. A small number suggested that while the practical orientation of the revised syllabus was a very good idea, it was unlikely to be effective without the employment of laboratory technicians.

"A great course if you had a lab tech and proper ICT resources in a lab"

"Need more technical support to be able to get away from class demos only"

"With all the equipments and practical work we now have to carry out, and the new demands on equipment, a lab technician is a necessity"

Time Demands

Although many of those who mentioned the need for a laboratory technician indicated that part of the reason was a shortage of time, a further 26% of those who made comments (14% of all teachers) independently mentioned shortage of time as a problem. Many of the comments referred to an increase in teacher workload as a consequence of the revised syllabus, while others felt that the course was too long to cover in the time allocated. Others specifically mentioned time constraints related to the practical elements of the course, usually suggesting that an additional double class per week was needed to do the course justice.

"No time has been allocated to teachers for preparation for all this work and clearing up after, ordering equipment/materials, logging/correcting/keeping records of mandatory experiments and Coursework B"

"While I welcome the increased student participation in investigative practical work, there has been a huge increase in my workload, free classes and lunchtime are spent preparing for practical classes"

"Five classes per week in my view are required to comfortably complete the course timewise - 2 doubles and 1 single"

Resource Needs

Sixteen percent of those who wrote comments (9% of all teachers) discussed the need for more resources. In particular, the need for increased access to school laboratories was cited as a problem. Many felt that it was difficult to complete practicals and the associated preparation and cleaning work in the time they were allocated. Specific resources mentioned as lacking were data projectors, dataloggers, and computers. Some pointed out that not only did they not have these resources, but that their laboratory could not accommodate them even if they were available. While most wanted additional physical resources, a small number mentioned the need for additional human resources (other than laboratory technicians). These included the need for smaller class sizes for practical lessons (implying that more teachers were needed) and the need for a science co-ordinator in each school.

"My modern new lab has 'no room' for a computer or other audio visual equipment"

"Access to lab only once a week a problem"

"Use of IT limited by pressure on computer room. Labs given computer room rejects!"

"JC science looks like a good idea but with lack of training and resources it will eventually become a subject taught from the textbook and done by experimental rote. You don't get much when you're cheap!"

Positive Aspects of the Syllabus

Fifteen percent of those who wrote additional comments (8% of all teachers) wrote positively about the revised syllabus or of their experiences teaching it, although many added a negative qualification. For example, some felt that while the students enjoyed the practical element, the teacher's workload had increased. Others felt the revised course was more interesting, but too long or too difficult to fit into the timetabled hours. Some felt that the course was generally good, but that time was required to sort out logistic issues and to establish the best methodologies, while a small number felt that the revised syllabus made it easier to get a good grade. Many commented on the high quality of the ICD provided, although again, this was sometimes coupled with a negative comment about the timing or quantity of ICD.

"Wish I was learning this course as a student - love it and love teaching it"

"Quantity of inservice poor, quality of inservice excellent!"

"I like the new J. science syllabus, especially the hands on approach by students, but a lot of prep work is required to have practicals set up & equipment ready for class"

"Attractive course. Students enjoy investigative approach. Seriously hampered by issues around laboratory"

"I feel the JCSS is a great improvement on its predecessor. I think it gives students a more practical experience of science and as a result they see science as being more fun and exciting, as well as challenging but approachable"

Timing of Coursework B

Eight percent of all respondents (15% of those who made comments) raised issues about the timing of Coursework B. All felt that the timing of the release of Coursework B titles was poor, and many felt that the time allowed in which to complete them was too limited. A particular point of concern was that the delay in sending schools the Coursework B titles meant that it had to be completed at the same time as mock examinations, mid-term break and Easter holidays. This was perceived to be a time when students' minds were focussed elsewhere. Some felt that while there appeared to be adequate time for students to complete Coursework B, no account was taken of schools with restricted laboratory access. Many suggested that Coursework B should be distributed before Christmas, while some suggested it should be done in Second Year. Others noted that projects for some other examination subjects also had to be completed at around the same time, causing unnecessary stress to students.

"Lateness of part B titles, prior to JC mocks, defies belief. Instructions on exact format details on completion of projects is a disgrace"

"Too many time demands Mar/Apr. Trying to monitor exam preparation and focus on write up of practicals coursework"

"With regard to the timing of the release of Coursework B - the titles are released at a time when Mock Exams, Mid-term breaks and Easter Holidays leave a very narrow time frame to complete the experiments. Therefore the students are somewhat rushed and do not have the time to take a full investigative approach to the topics at hand"

"My 3rd years have CPSE, religion, science and possibly art and construction projects all to do around the time of the pre-examinations. The Department should spread out their workload over 2nd and 3rd year better"

How Marks are Obtained

Almost 14% of those who made an additional comment (7% overall) referred to the structure of the marking scheme for Junior Certificate science, to how marks were obtained in practice, and to how the examination papers were designed. A number were unhappy that there was no choice on the paper. Some felt this disadvantaged weaker students while others felt that it made it harder to achieve a high grade. There were mixed views about the appropriateness of the marks allocated to Coursework. In Chapter 6, we noted that most teachers were satisfied with the principle of allocating a considerable percentage of marks to the practical element of the course. However, some were dissatisfied with how the marks were distributed between the two types of Coursework. For example, some felt that 25% was too much for a few weeks work (Coursework B), or that 10% did not reflect the amount of work demanded by Coursework A.

Many also expressed doubts about how well the marks assigned to Coursework would reflect a student's capabilities. While a few raised the issue of Coursework being graded by Assistant Examiners with little or no experience in grading such work, most were worried that Coursework was not necessarily students' own work. For example, some felt that parents would help their children, while others felt that some teachers would do most of the work for students. Consequently, some felt that the marks assigned to Coursework should be reduced, while others felt that the State Examinations Commission should incorporate a practical element into the examination - with equipment supplied and activities supervised by personnel from the Commission.

"The lack of choice in the final exam mitigates (sic) against students achieving A grades and simply serves to make the process of correcting easier and less cumbersome"

"I feel that the project work in Coursework B is open to abuse/cheating and should not be"

"I strongly feel that the students should be inspected (externally) on-site doing science investigations. Coursework A is in danger of becoming a form-filling exercise. Students can get full marks for copying out experiments without having done them"

Logistical/Implementation Issues

Thirteen percent of those who made comments (7% of all respondents) referred to logistical problems with the implementation of the revised syllabus (other than the late release of Coursework B titles). Some referred to an inadequate amount of ICD, with others pointing out that there did not appear to be supplementary ICD for those who missed the original series (for example, those on career breaks)[4]. While most felt that the ICD offered was of good quality, some felt it presumed access to certain laboratory equipment and ICT resources, while others complained that it did not supply answers to basic questions. For example, a few indicated that they did not know how to deal with students who had missed some of the mandatory experiments or with students who had lost their lab notebooks.

There were also complaints about the late availability (or unavailability) of aids such as sample completed investigations, sample exam papers, and finalised, published teacher guidelines. A number of teachers also criticised the question style on the sample papers, indicating that some students found it off-putting or hard to understand.

"Having an inservice on "sequence of teaching" new course when the first three years are over seems a bit strange!!"

"Samples of completed investigations highlighting correct method of approach etc. would be useful for students"

"More guidance needed with new Project"

"The course is now 3 years in operation & the first group are being examined in June yet no guidelines for the revised syllabus have been published"

The Revised Syllabus and Weaker Students

Nine percent of those who made additional comments (5% of respondents) referred to how the revised syllabus affected weaker students. However, views were evenly divided between those who felt weaker students were in a better position than before and those who felt that the new syllabus put them at an even greater disadvantage. The practical element was praised by some, who felt it engaged weaker students, or made it easier for them to obtain marks, or that it rewarded students for the ability to do something, rather than just write about it.

In contrast, others criticised the organisation of Coursework because they felt that marks were assigned for writing up experiments, not for being able to conduct them properly or being able to explain verbally what had been done. Some also mentioned the volume of material that had to be covered as being somewhat confusing or overwhelming for weaker students.

[4] Supplementary ICD targeting those who missed the first set of seminars will be available during the 2006/07 academic year.

"[students with a learning difficulty] … can do the experiment and discuss what has happened but cannot write about it. No marks are awarded for actually doing the experiment, all the marks are given for writing it up. Once again these students are penalised for what they don't know and not rewarded for what they do know and what they can do practically"

"I find the new Junior Cycle much better for those students who do not do so well in written exams. It allows their lab work to make a difference to their result"

Health and Safety Issues

Three percent of those who made comments (2% of respondents) raised health and safety issues. All indicated that they had not received any health and safety training associated with the introduction of the revised syllabus[5]. Some indicated that a large group of students simultaneously performing experiments in a laboratory represented a considerably higher risk setting than a teacher performing a demonstration. In particular, some mentioned fears about the behaviour of disruptive students and weaker students, who were either unwilling or unable to follow instructions.

"It appears no one thought of the safety aspects of the practicals when done by a class of 28 students - some of whom are not able to read"

"Without a lab technician, unruly kids place restrictions on practical work"

Other Comments

A number of teachers (5% of all respondents) made additional comments that did not fall into any of the categories shown in Table 7.1. Some said that they did not see much difference between the revised and older syllabus, or that they had always used the investigative approach. Others thought that there had been considerable change and suggested that it would take time for teachers to become comfortable using the investigative approach or the new methodologies. A small number of responses related to the position of science in the post-primary school timetable, including its time allocation, and the fact that it is not a core subject.

A number of additional comments could be classified as broad, negative statements about the capabilities of students today. These included comments such as suggestions that mathematical skills have declined, that attitudes to learning (and to learning science in particular) are less positive, that students do not seem able to learn definitions any more, or that students did not like an independent style of learning, wanting instead to be 'spoon-fed'.

[5] Health and safety training was integrated into ICD related to the introduction of the revised syllabus, rather than included as a separate module.

8 Conclusions and Discussion

In this chapter, we discuss the implications of our findings. Only broad linkages between PISA scientific literacy and teacher responses are possible as PISA achievement data have not yet been released. However, the teacher survey provides considerable information about the rJCSS. Given the very high teacher response rate (in a representative selection of schools), we can conclude that the views expressed are representative of those teaching Junior Certificate science classes.

The Aims of the rJCSS

The rJCSS was intended to differ from its predecessor in a number of ways, including reduced length, increased emphases on scientific investigation, on applying scientific processes, and on understanding the scientific concepts involved. It is also intended to provide a better match with the contents of the primary school science syllabus, and to reduce the focus on the terminal written examination paper. Teacher responses suggest success in achieving at least some of these aims. They report greater use of investigative approaches by both themselves and their students, and improved student ability to apply scientific processes. Our data also show that most teachers agree with the allocation of approximately one-third of marks to practical work. Indeed, less than 3% felt that all marks should be derived from the written paper. In this regard, the revised syllabus has achieved its aim of reducing the emphasis on the final written examination paper.

However, while an introduction to the primary school science syllabus was included as part of the in-career development (ICD) programme for the rJCSS, it does not seem to have fostered an understanding of the primary syllabus among most survey respondents. Most teachers (all teaching Junior Cycle students) described themselves as unfamiliar with the science content and processes in primary school science. It would seem important to address this issue if teachers are to create a smooth transition across the two syllabi for students.

Among the hoped-for benefits of the rJCSS were a better balance between biology and the physical sciences, and an increased uptake of science subjects at Senior Cycle and at third level. Most teachers of Leaving Certificate biology felt that the rJCSS provided adequate preparation for that course, but only a minority of teachers of Leaving Certificate physics or chemistry felt that students were adequately prepared for their courses. It may be that the rJCSS has not achieved a balance between the three core science subjects. However, since most teachers were satisfied that the rJCSS helped students to understand how science is used in the real world, and to develop a positive attitude about science, it may be that some changes are required at Senior, not Junior, Cycle in order to produce better linkages between the two levels. It is too early to establish definitively if uptake at Senior Cycle will increase, but the perception of a lack of preparedness for chemistry and physics suggests it may not.

Implementation of the rJCSS

The rJCSS can be examined in two ways - the syllabus as intended in theory, and how it has been implemented in practice. Our data indicate that while many teachers support the syllabus as theoretically constructed, there are difficulties with its implementation. There was widespread dissatisfaction with the amount of information provided on assessment procedures. There were also complaints about the lack of, or inadequacy of, other documentation to support the implementation of the syllabus. For example, the final teacher guidelines had not been published (only web-based, draft guidelines are available [NCCA, 2006]), and dissatisfaction was expressed with the quality of textbooks, the perceived delay in issuing sample exam papers, and the lack of sample completed investigations.

In fact, it was never intended that teachers be provided with sample investigations. Instead, general support in this area was provided by the Junior Science Support Service. However, this does not seem to have been communicated to all teachers. Similarly, a small number of teachers wanted the Department of Education and Science to provide generic forms such as worksheets for investigations. Such worksheets are available on the *juniorscience.ie* website, but some teachers may not have been able to find them on the website, while our data also suggest that a sizeable minority of teachers have never used the website. We suggest that improved communication would resolve many of the issues raised about the implementation of the syllabus.

Some other implementation difficulties also seem easily remedied. For example, earlier distribution of Coursework B titles would allow students more time to complete them, also solving problems with limited laboratory access and clashes with project work for other subjects. Similarly, 'catch-up' ICD for those who missed the original sessions seems a relatively simple logistical problem to overcome, and is scheduled as part of the work of the Junior Science Support Service for the 2006/07 academic year.

Textbooks can influence the implementation of a syllabus, particularly if, as we found, teachers use them far more commonly than other resources when planning lessons. However, 37% of teachers described poor quality textbooks as an impediment to teaching science. This suggests that textbook publishers and authors, in consultation with subject and curriculum experts, need devote greater attention to ensuring that textbooks adequately reflect and support the aims, objectives and content of the syllabus.

The lack of laboratory assistance was widely perceived as hampering syllabus implementation, and was also cited as a problem in a recent survey of science teachers (mainly in secondary schools) (ASTI, 2006). Many felt that the rJCSS had significantly increased their laboratory workload without any decrease in their class contact hours. Issues of preparation and clean-up time were raised, as well as fears about supervision and safety issues when large numbers of students were performing experiments. The employment of technical assistants was one of the recommendations of the Task Force on the Physical Sciences in 2002. It remains a relevant recommendation.

The rJCSS and PISA Scientific Literacy

Theoretically, the rJCSS is more closely aligned than its predecessor to the PISA framework for scientific literacy. Our data suggest that classroom practice has also become better aligned with scientific literacy as conceptualised in PISA. For example, teachers reported increased use of investigative approaches and a perception that the course is more relevant to students' everyday lives. Further, while the 1995 TIMSS international study found that teachers in Ireland were among those least likely to believe it important that students understand how science is used in the real world (Beaton et al., 1996), our survey found that most teachers reported using real-world examples in most lessons. Further, most reported that their lessons emphasised key elements of the PISA science framework. For example, one-third placed 'a lot' of emphasis on interpreting scientific evidence, on drawing and explaining conclusions and on applying scientific knowledge.

An important element of PISA scientific literacy is that students should be able to evaluate if claims are scientifically sound. Such claims need not necessarily be major scientific theories, but everyday claims such as those made in advertisements or newspapers. However, most teachers felt that the rJCSS would have little effect on students' ability to read critically a newspaper or magazine article about a scientific experiment. This may be because, although teachers reported using real-world examples in lessons, real-world materials such as newspapers, magazines or Internet articles are rarely used in science lessons.

Distinguishing between scientific and non-scientific explanations and between questions that can or cannot be answered using a scientific approach were the two aspects of the PISA framework that received least emphasis in Junior Cycle science lessons. PISA 2006 (and its predecessors) includes a small number of items that ask students if specified questions can be answered using a scientific approach. Irish students have performed reasonably well on such items in the past, despite apparently limited exposure to such concepts during science lessons. It remains to be seen what effect, if any, the rJCSS will have on how students perform on such items in the future.

Finally, the rJCSS represents a closer alignment with the concept of scientific literacy, as defined in the PISA framework. However, in terms of content, some of the topics covered may be less familiar to those studying the revised syllabus than they would have been to those who studied the older syllabus. For example, PISA 2006 contains four major categories covering knowledge of science - Physical Systems, Living Systems, Technology Systems, and Earth and Space Systems. The latter category receives considerably less coverage in the revised syllabus than in the pre-2003 syllabus.

Overall, our data suggest that the revised syllabus has achieved some, but not all, of its aims. There appears to have been a shift to a more practical method of teaching science, but this change has been hampered by some implementation difficulties. In theory at least, the revised syllabus at Junior Cycle is more closely linked than its predecessor to scientific literacy as defined by the PISA framework.

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