2007 Scottish Survey of Achievement (SSA) Science, Science Literacy and Core Skills

What is the SSA?

The Scottish Survey of Achievement (SSA) is a sample survey which monitors how well pupils in Scotland are learning. Each year the SSA focuses on a different aspect of the school curriculum. In 2007, the focus was Science and between April and June 2007, just under 40,000 pupils in P3, P5, P7 and S2 from around 1,100 Scottish schools took part in the survey.

Using written assessments, the 2007 SSA investigated pupils' knowledge and understanding in Science and their Science literacy. A small number of pupils also took part in practical activities to assess their investigation skills and some core skills[1] in a Science context, along with further aspects of Science literacy. Pupils' skills were evaluated by visiting teachers. For another group of pupils, examples of their writing in a Science context were marked by their own teachers and then moderated by a central team of teachers from across Scotland.

The survey also collected teachers' professional judgements about sampled pupils' levels of achievement in science, reading, writing and mathematics. In addition, information from pupils and their teachers about their experiences and views of learning Science was gathered from questionnaires.

This report explains some of the high-level results. More detailed information and full results are contained in *2007 Scottish Survey of Achievement (SSA) Science, Science Literacy and Core Skills – supporting evidence* which can be downloaded at www.scotland.gov.uk/ssa2007supportingevidence.

1 Problem solving, information and communications technology (ICT) and working with others.

What do the survey results tell us?

Science Knowledge and Understanding

Pupils' knowledge and understanding of Science (the main focus of the survey) were determined through written assessments covering the three Science attainment outcomes which are set out in the 5-14 Environmental Studies guidelines. These outcomes are *Earth and Space, Energy and Forces* and *Living Things and the Processes of Life.*

Interpreting SSA results

Estimates of performance in Science knowledge and understanding and Science literacy are based on the results of written assessments which are reported as follows:

- pupils who answered 80 per cent or more of the questions correctly – 'very good' skills
- pupils who answered 65 per cent or more of the questions correctly – 'well-established' skills
- pupils who answered 50 per cent or more of the questions correctly – 'made a good start' with skills, but need more practice.

Pupils whose skills were found to be 'well-established' or better are considered to be secure at a level.

As the charts on page 3 show, for Science knowledge and understanding:

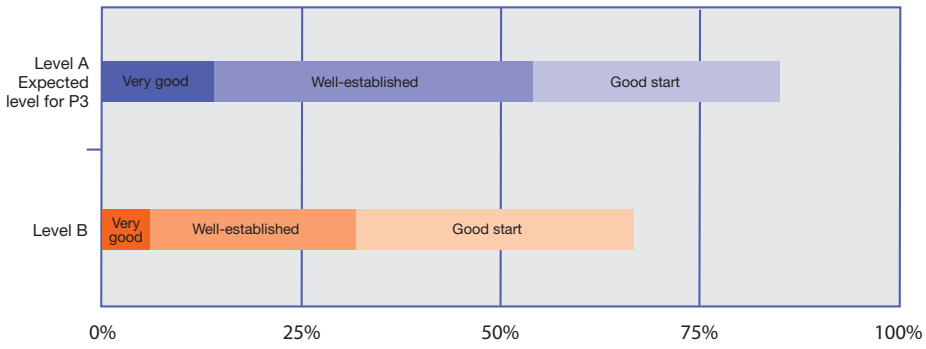
- almost 55 per cent of P3 pupils were well-established or better at Level A and just over 30 per cent were already well-established or better at Level B
- just under half of pupils in P5 were well-established or better at Level B (the expected level for P4) and around one in ten were well-established or better at Level C (the expected level for P6)
- performance was less strong at P7, where six per cent of pupils were well-established or better at their expected level (Level D)
- in S2 just over 15 per cent were well-established or better at Level E.

The findings suggest a significant number of pupils are not achieving expected levels, particularly in P7 and S2.

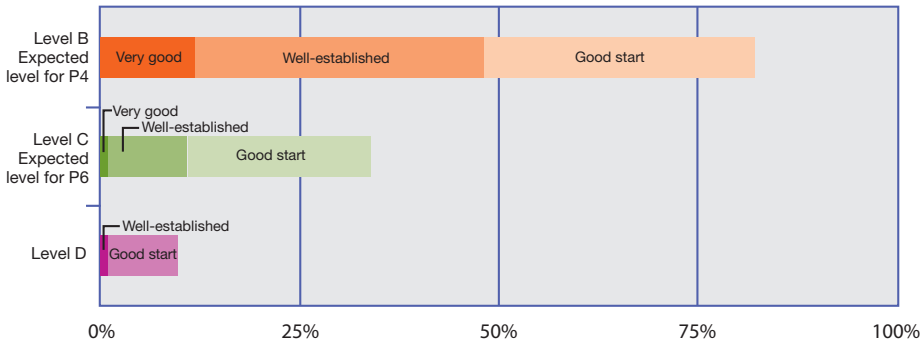
The 2007 SSA was not designed specifically to allow direct comparisons over time with the results from the 2003 Assessment of Achievement Programme[2] Science survey (AAP was the precursor to the SSA), but around a fifth of knowledge and understanding tasks used in the 2007 survey were used in 2003. A comparison of results for these tasks indicates that there has been no change in Science achievement between 2003 and 2007.

2 The report of the AAP Science survey in 2003 can be accessed at: http://www.scotland.gov.uk/Publications/2005/03/20882/54916

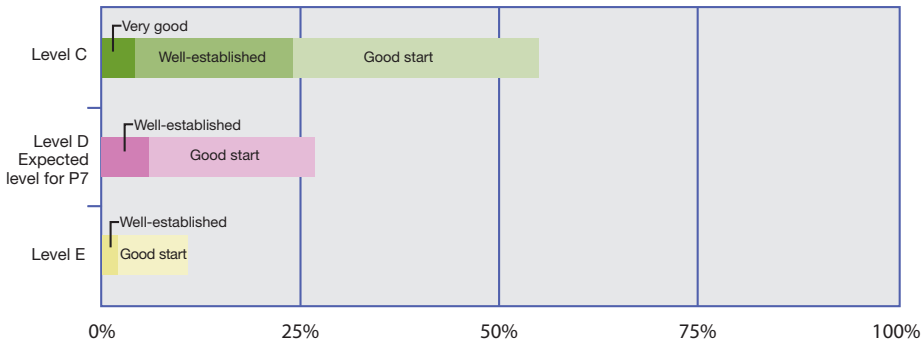
ACHIEVEMENT IN SCIENCE KNOWLEDGE AND UNDERSTANDING - P3



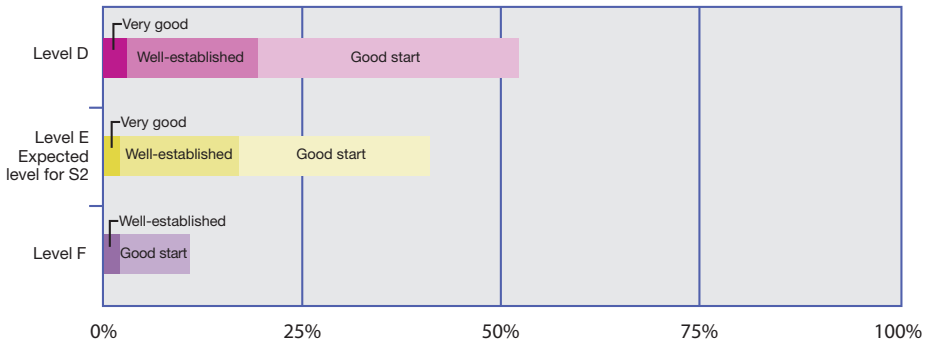
ACHIEVEMENT IN SCIENCE KNOWLEDGE AND UNDERSTANDING - P5



ACHIEVEMENT IN SCIENCE KNOWLEDGE AND UNDERSTANDING - P7



ACHIEVEMENT IN SCIENCE KNOWLEDGE AND UNDERSTANDING - S2



How to read these charts

The current 5-14 curriculum in Science is described at six levels, A-F. Most pupils are expected to progress through a level in about 18 months to two years: Level A by the end of P3; Level B by the end of P4; Level C during P5-P6; Level D by the end of P7; Level E (and Level F for a few) by the end of S2.

Each level is shown on the charts in a different colour. By following the colour down the page for the different stages (P3, P5, P7, S2) you can see how progressively more pupils at each stage demonstrate successfully the knowledge and understanding for one level and build on them for the next.

Approaches to Assessment

The principal aim of the 2007 SSA was to produce national estimates of achievement in Science knowledge and understanding for pupils across Scotland at different stages in their education. However, the SSA in general is also expected to play a role in demonstrating effective assessment approaches as well as offering continuing professional development to teachers. In order to meet all of these needs, the survey employed a number of different approaches to assessing pupil attainment including written assessments, practical activities and teachers' judgements. The following should therefore be taken into account when considering the results presented in this report:

- Science literacy assessments were tried out in the 2007 survey for the first time. They were based on a very small number of tasks per level and the associated achievement results should therefore be treated as indicative
- due to logistical constraints, the practical assessments involved a much smaller group of pupils than other parts of the survey. Their results are therefore less dependable and cannot be broken down by gender or deprivation. Nevertheless, they provide useful information about important learning skills. Some of the practical tasks were not assessed in terms of 5 to 14 levels but instead recorded the amount of evidence of the skill which each pupil demonstrated
- written assessments and teachers' judgements represent two very different approaches to gathering information on pupil achievement. One is based on performance in a particular assessment on a particular day and the other on a range of knowledge gained over a period of time. Some of the differences emerging in the results may not therefore be surprising.

Science Literacy

The 2007 SSA tried out a new assessment of pupils' 'Science literacy', using both written and practical assessments. This was our first attempt at assessing Science literacy and the scale of the exercise was limited compared to a full national assessment. Therefore, the results should be treated as indicative. The description of Science literacy adopted for the survey was that used by the Nuffield Foundation[3] and is described below:

We would expect a scientifically literate person to be able to:

- *appreciate and understand the impact of Science and technology on everyday life*
- *take informed personal decisions about things that involve Science, such as health, diet, use of energy resources*
- *read and understand the essential points of media reports about matters that involve Science*
- *reflect critically on the information included in and (often more important) omitted from such reports*
- *take part confidently in discussions with others about issues involving Science.*

In the Science literacy written assessments, pupils read about Science and undertook a task evaluating their understanding of the source material (using literacy skills). They were then assessed on their ability to reflect critically on information in, or related to, the text and reach evidence-based conclusions. Achievement at all stages was higher than for knowledge and understanding of Science:

- a high proportion of pupils in P3, just over 80 per cent, were classified as well-established or better at Level A
- in P5, just over 45 per cent of pupils were well-established or better at Level C
- at P7, just under 30 per cent of pupils were well-established or better at Level D

3 http://www.21stcenturyscience.org/rationale/scientific-literacy,903,NA.html

- in S2, the proportion at Level E was around 40 per cent
- the results also suggest greater variation in achievement at P7 and S2. For example, a third of pupils in S2 were already well-established or better at Level F, the level above that expected.

Science Literacy Practical

As a separate exercise, a small sub-sample of pupils took part in one-to-one conversations with a visiting teacher acting as a field officer to investigate further their Science literacy skills. The discussion covered, for example, awareness of scientific issues and the ability to reflect critically on scientific information. Pupils were rated on a three-point scale for each skill. The results show performance improving as stage increases. At P3, around 60 per cent of pupils were rated in the middle or the top of the scale. This increased to over 75 per cent at P5 up to almost 90 per cent in both P7 and S2.

Scientific Investigation

A further sub-group of pupils was asked to carry out a scientific investigation during class time and record what they had done. They later took part in a one-to-one discussion with the visiting field officers which covered *Preparing, Carrying out, Reviewing and Reporting on Tasks.* At all stages, a high proportion of pupils were judged to be well-established or better at their expected levels by the field officers.

At P3, 98 per cent of pupils were judged to be at Level A or better and around 15 per cent of these pupils were judged to be already at Level C or better, well beyond their expected level. At P5, 90 per cent of pupils were judged to be at Level B or better and over 70 per cent were judged to be at Level C or better. At P7, just over 50 per cent were judged to be at or above Level D and at S2, just under 50 per cent were judged to be at Level E.

Writing in a Scientific Context

To assess pupils' ability in writing within a Science context, schools were asked to submit examples of class-based writing for a sub-group of pupils. The results show that greater proportions of pupils at the lower primary stages were writing at expected levels or better, compared to P7 or S2. At P3, more than 90 per cent of writing was at Level A or better. At P5, a similar proportion was at Level B or better. At P7, around 50 per cent of writing was at Level D or better and at S2 around 25 per cent was at Level E or better.

Teachers' Judgements of Achievement in Science

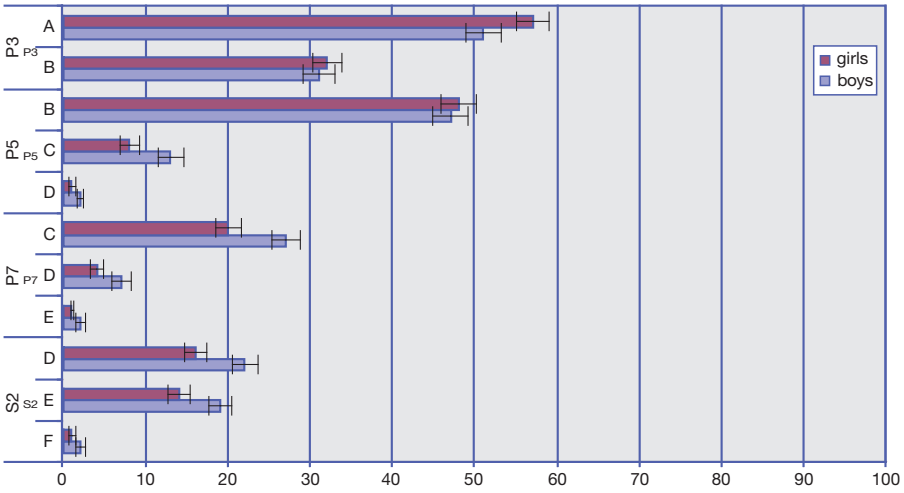
In addition to the written assessment of the different elements of Science, teachers were invited to provide their own judgements about overall Science achievement for each pupil sampled in the survey. At all stages, teachers judged most pupils to be either at the expected level for the stage or within one level of it. At P3, most pupils were judged to be at Levels A and B. At P5, most were judged to be at Levels B and C. At P7, most were judged to be at Level C or D and at S2 most were judged to be at Levels D and E.

Gender and Achievement in Science

The survey results revealed some gender differences in knowledge and understanding. A greater proportion of girls than boys were well-established or better at Level A in P3. At Level B, in both P3 and P5, the proportions of boys and girls achieving expected levels was similar. This switched to a consistent difference in favour of more boys than girls being well-established at Level C and above in P5, P7 and S2. Teachers, on the other hand, tended to judge girls to be performing slightly better than boys in Science as a whole across the stages. In contrast, there were no consistent gender differences noted in Science literacy achievement.

The gender findings for Science knowledge and understanding in Scotland are similar at Level C and above to international studies in Science, where consistent differences are found generally in favour of boys.

ACHIEVEMENT IN SCIENCE KNOWLEDGE AND UNDERSTANDING BY GENDER
(% pupils having "well-established" skills or better at the given level)



How to read these charts

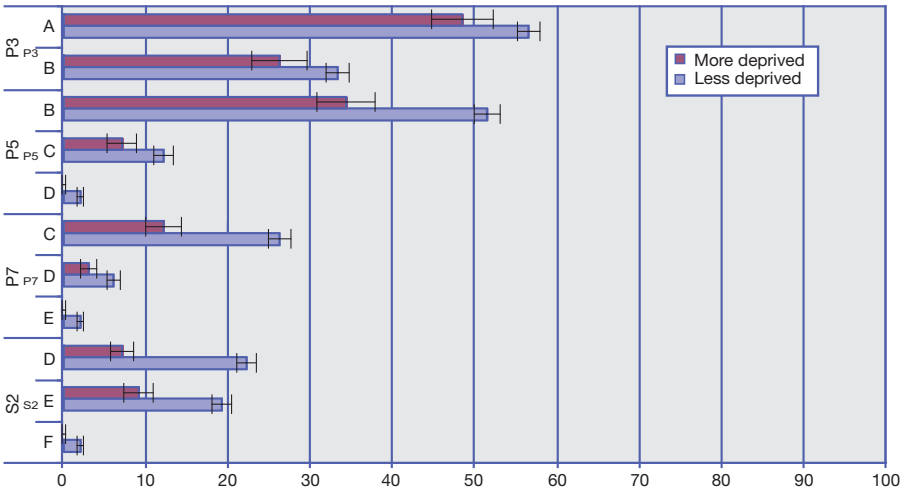
The thin black lines at the end of each bar represent confidence intervals. Because the results are esimates based on a sample of pupils, we use confidence intervals to show the range of values within which the real attainment level lies. More information is given under "Sampling for the SSA" (on page 8).

Deprivation and Achievement in Science

For knowledge and understanding in Science, pupils from less deprived areas achieved higher levels than pupils from the 20 per cent most deprived areas[4], at all stages and at all levels assessed. All differences were statistically significant and increased with stage, with the largest differences at S2. For Science literacy there was also significantly higher achievement amongst pupils from less deprived areas than pupils from the more deprived areas at almost all stages and levels.

It is well known that relative deprivation and socio-economic status impact on pupils' achievement. The results we see here are in line with international studies in Science and with the results from the 2006 SSA which focused on strands of social subjects enquiry skills along with reading and numeracy. The impact of deprivation was also highlighted in the recent OECD review of schooling in Scotland[5].

ACHIEVEMENT IN SCIENCE KNOWLEDGE AND UNDERSTANDING BY DEPRIVATION
(% pupils having "well-established" skills or better at the given level)



4 As defined by the 2004 Scottish Index of Multiple Deprivation

5 Quality and Equity of Schooling in Scotland, OECD, www.oecd.org/document/18/0,3343,en_2649_37455_39744402_1_1_1_37455,00.html

Sampling for the SSA

SSA results are based on a random sample of pupils. Because we use a sample rather than all pupils the results are estimates and may vary from the true values. By selecting more or fewer pupils we can make more or less accurate estimates. The number of pupils we select is therefore a balance between improving the accuracy needed in order to say something meaningful about pupils' achievement and limiting the burden on pupils and schools.

To give an indication of the accuracy of a figure, statisticians calculate a confidence interval around it. This gives a range of values around the estimate within which we are confident the true value lies (similar to the 'plus or minus x per cent' type figures that are often quoted with opinion polls). In this report we use 95 per cent confidence intervals. For example, the estimated proportion of P3 girls well established or better at Level A is
57 per cent plus or minus two percentage points. The confidence interval is therefore 55 per cent to 59 per cent, which means we are 95 per cent confident the true value lies somewhere in this range.

When comparing results, the accuracy of the estimate should be taken into account. When the confidence intervals do not overlap, we are confident that there is a 'real' difference. We would refer to this as being a 'statistically significant' difference.

Core Skills

Pupils were assessed on the core skills which underpin learning across the existing curriculum.

Reading, writing and *mathematics* were assessed by gathering teachers' judgements of achievement. These displayed a similar pattern to their judgements about Science. In general they judged pupils to be at or around the expected levels, although as stage increased judgements tended to become more widely spread across levels. For both reading and writing teachers' judgements placed more girls than boys at the highest levels, whereas in mathematics, there was no evidence of any gender difference.

In order to assess pupils' *working with others, problem solving* and *ICT* skills, teachers, nominated by local authorities as field officers, visited a sub-group of the pupils participating in the survey in the pupils' own schools. They carried out practical assessments (these were the same field officers that assessed Science literacy and Science investigation practicals).

For *working with others*, most pupils were found to contribute ideas and participate freely in the discussion and displayed at least some evidence of listening to others' ideas and building on them. In general, pupils were rated highest on their motivation, with over 90 per cent of pupils in all year groups addressing their given task and showing 'some interest in completing the task'. The proportion of pupils who made little contribution to the discussion or showed no evidence of listening to others was higher at P3 and S2 than at P5 and P7.

For *problem-solving* skills, again P5 and P7 groups tended to perform better than those in P3 and S2. For example, field officers judged that nearly two-thirds of P5 and P7 groups displayed strong evidence of coming to a consensus over a strategy, compared to around half of S2 groups and a third of P3 groups. Across the stages, fewer than five per cent of groups failed to complete the task.

For *ICT* skills, almost all P3 pupils were estimated by field officers to be at Level A or better and over half of P7 pupils demonstrated skills at Level D or better. At S2, 45 per cent were judged to be at Level E or better while 11 per cent were at Level F.

Pupil and Teacher Questionnaire Results

About Our Teachers

In total around 4,000 teachers from about 1,000 of the primary and secondary schools participating in the survey completed questionnaires about their experience of Science teaching and learning. Of these, around three quarters had been teaching for more than five years, while just under one in ten were in their first year of teaching. More than nine out of ten primary teachers were female, whilst the gender split was about half and half in secondary school. This is broadly representative of the national gender profiles of the sectors.

Teaching Science:

Almost all primary teachers taught Science to their own classes. Six per cent of respondents reported that a specialist within the school either taught their class Science or shared Science teaching with them. Five per cent reported an external specialist either teaching their class or sharing the teaching with them in Science. At S2, around four in every five teachers taught an integrated Science curriculum rather than separate Science subjects.

Teachers' Confidence in Science:

Around 90 per cent of the primary teachers were fairly or very confident teaching biology topics, but far fewer were confident about teaching chemistry (60 per cent) or physics (just over half). At secondary, at least 90 per cent of teachers were fairly or very confident in teaching Science, (biology, chemistry or physics).

At primary stages, female teachers were slightly more confident than their male colleagues when teaching biology topics, whilst male teachers tended to express more confidence than female teachers when teaching topics with chemistry or physics themes. At S2, a greater proportion of female than male teachers were confident about teaching biology but a far greater proportion of male than female teachers were very confident about teaching physics. There was no difference in the proportion of male and female teachers expressing confidence in teaching chemistry at S2.

CPD in Science:

Fifteen per cent of the primary teachers had taken up more than two Science CPD opportunities over the previous four years, but nearly 40 per cent had not taken up any. In S2, nearly two-thirds of the teachers had taken up more than two CPD opportunities over the same period, with male teachers taking up more opportunities than females. Secondary teachers were also generally happier with their CPD opportunities.

About Our Pupils

In total more than 38,000 primary and secondary pupils completed questionnaires about their experience of Science and Science learning.

Self-Assessment by Pupils:

One of the questions pupils were asked was "How good do you think you are at Science?" and this allowed them to rate themselves as 'exceptional/very good', 'good/above average', 'average' and 'poor' with 'don't know' as a possibility. The responses revealed evidence of a gap between pupils' self-assessments and their actual levels of achievement for knowledge and understanding in Science, with many of the pupils who performed below expected levels in the survey assessing themselves as good or very good at Science. However, the proportions rating themselves above average in Science fell from P3 to P5 to P7, with little change between P7 and S2.

Boys tended to rate themselves more highly in Science than girls, a gender gap which is in keeping with the Science knowledge and understanding results at the higher levels.

At primary stages a greater proportion of pupils from more deprived areas rated themselves 'exceptional/ very good' than pupils from less deprived areas. Conversely, at S2 a greater proportion of pupils from less deprived areas rated themselves positively.

Pupils' Confidence in Science:

Pupils said they were most confident when doing experiments, talking about Science with their teachers or talking about Science in small groups. However, pupils in P3 and S2 were less confident about discussing Science in small groups than pupils in P5 and P7. In general, more boys said they were confident about Science than girls, especially at S2 in relation to doing experiments and investigations and talking about Science with their teachers.

Pupils' Ambitions in Science:

A high proportion of pupils at all stages (80 per cent among P3 and P5 pupils and 70 per cent among P7 and S2 pupils) agreed that they wanted to do well in Science. Around three-quarters of all the sampled pupils felt that Science learning would be useful for later study in other subjects and almost three-quarters of the S2 pupils agreed that studying Science would benefit them when they came to apply for jobs.

Pupils' Interest in Science Topics:

Pupils' self-reported interest in school Science topics was highest at P3 and tended to decrease with stage. Pupils generally showed good awareness of Science topics in the news, especially by S2, where boys in general seemed to have heard of more topics than girls. However, few pupils thought that these topics affected their own lives and even for topical issues like diet and exercise, climate change and pollution, only around a third of pupils felt they were relevant to them personally.

Pupils' Attendance, Motivation and Behaviour:

Almost all primary teachers and around 85 per cent of S2 teachers thought their pupils' attendance, behaviour and motivation in Science lessons were 'good' or 'very good'. However, teachers' 'very good' ratings for motivation to learn and classroom behaviour became steadily less frequent from P3 to S2. Attendance, motivation and behaviour were rated less positively for those pupils who lived in more deprived areas.

Learning, Teaching and Assessment in Science

Science Resources and Activities:

The most frequently used resource in Science teaching was the national *5-14 guidelines* used 'during most lessons' by almost 40 per cent of primary teachers and over 45 per cent of S2 teachers. There was also some use of commercial textbooks or resource packs and 5-14 guidance produced by the local authority. Teachers made less use of *Improving Science Education 5-14* materials, visiting specialists or electronic equipment.

Teachers and pupils generally agreed about the range of activities they experienced in Science lessons during most weeks. The most common were teaching the whole class together and pupils working with a partner or a group on a shared task.

More primary than secondary pupils said they completed worksheets during most lessons, while more secondary pupils (over 60 per cent) than primary said they often copied down information about Science and also carried out investigations and used Science equipment during most lessons.

Around a third of P3 and just over a quarter of P5 pupils, but only around 10 per cent at P7 and five per cent at S2, attended Science clubs in or outside school.

Assessment of Science:

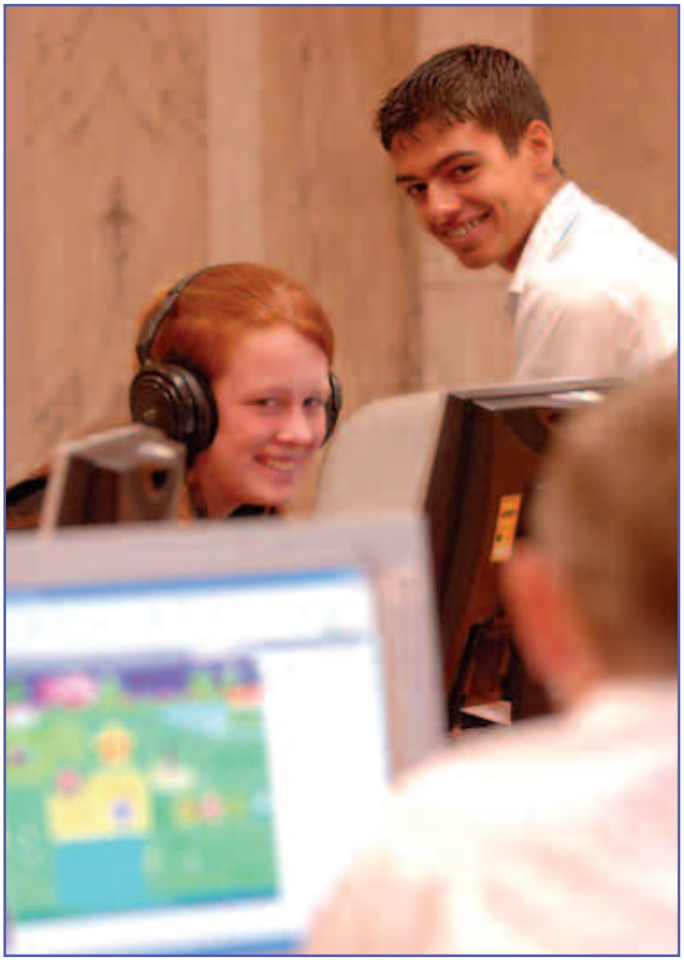
Primary teachers used different approaches to assessment in Science more often than S2 teachers and female teachers at S2 tended to make more frequent use of a range of approaches than males. More primary and female teachers than secondary and male teachers said they were using formative assessment and personal learning planning approaches with their pupils.

How will the results of the survey be used?

The information from the 2007 SSA provides a broad picture of Scottish pupils' learning and achievements in Science. It will be used to help those involved in education to plan for improvements in curriculum, learning and teaching and resources in schools and so help to raise levels of achievement in Science in Scotland's schools.

Questions for us all to think about

- What could be done to encourage pupils to think of Science as relevant and important to their lives beyond the school, whether or not they intend to specialise?
- How can partnerships with others best be developed in the learning community to support children's learning in science at the transition from P7-S1?
- How can the *Curriculum for Excellence* outcomes and experiences be used to support and consolidate pupils' learning in Science?
- To what extent do Science programmes provide a good balance between knowledge and understanding and Science investigation skills?
- Is the continuing professional development in Science that teachers are offered properly meeting their needs and developing their confidence in Science teaching?
- How can staff be encouraged to assess pupils' progress in Science in a range of different ways and share expectations and standards in Science with other teachers across Scotland?



Want to know more?

The SSA in Scottish schools

This survey is about attainment in Scottish schools as a whole. If you would like more information about the results of the SSA, for this and other surveys, and how the survey works, please visit Learning and Teaching Scotland's assessment website at www.ltscotland.org.uk/assess/of/ssa. Information on further learning resources will be made available on the website.

Curriculum for Excellence

Curriculum for Excellence aims to achieve a transformation in education in Scotland by providing a coherent, more flexible and enriched curriculum from 3-18, firmly focused on the needs of the child and young person and designed to enable them to develop as successful learners, confident individuals, responsible citizens and effective contributors. For more information on *Curriculum for Excellence* please visit www.curriculumforexcellencescotland.gov.uk

HMIE

HM Inspectors of Education (HMIE) promote sustainable improvements in standards, quality and achievements for all learners in Scottish education through independent evaluation. If you would like information about inspections of Scottish schools, or are interested in knowing more about good practice in Scottish education please visit www.hmie.gov.uk

International studies

If you would like to learn more about international studies, including Scotland, please visit www.scotland.gov.uk/Topics/Education/Schools/Excellence/IE

Your child's progress and achievements

If you would like to know more about how your own child is progressing, or you have concerns about their learning, you should get in touch with the school and talk to your child's teachers.

You will find more information about education in Scotland, and advice on supporting your child's learning on the Parentzone website www.parentzonescotland.gov.uk

This document is also available on the Scottish Government website: www.scotland.gov.uk/ssa2007report

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