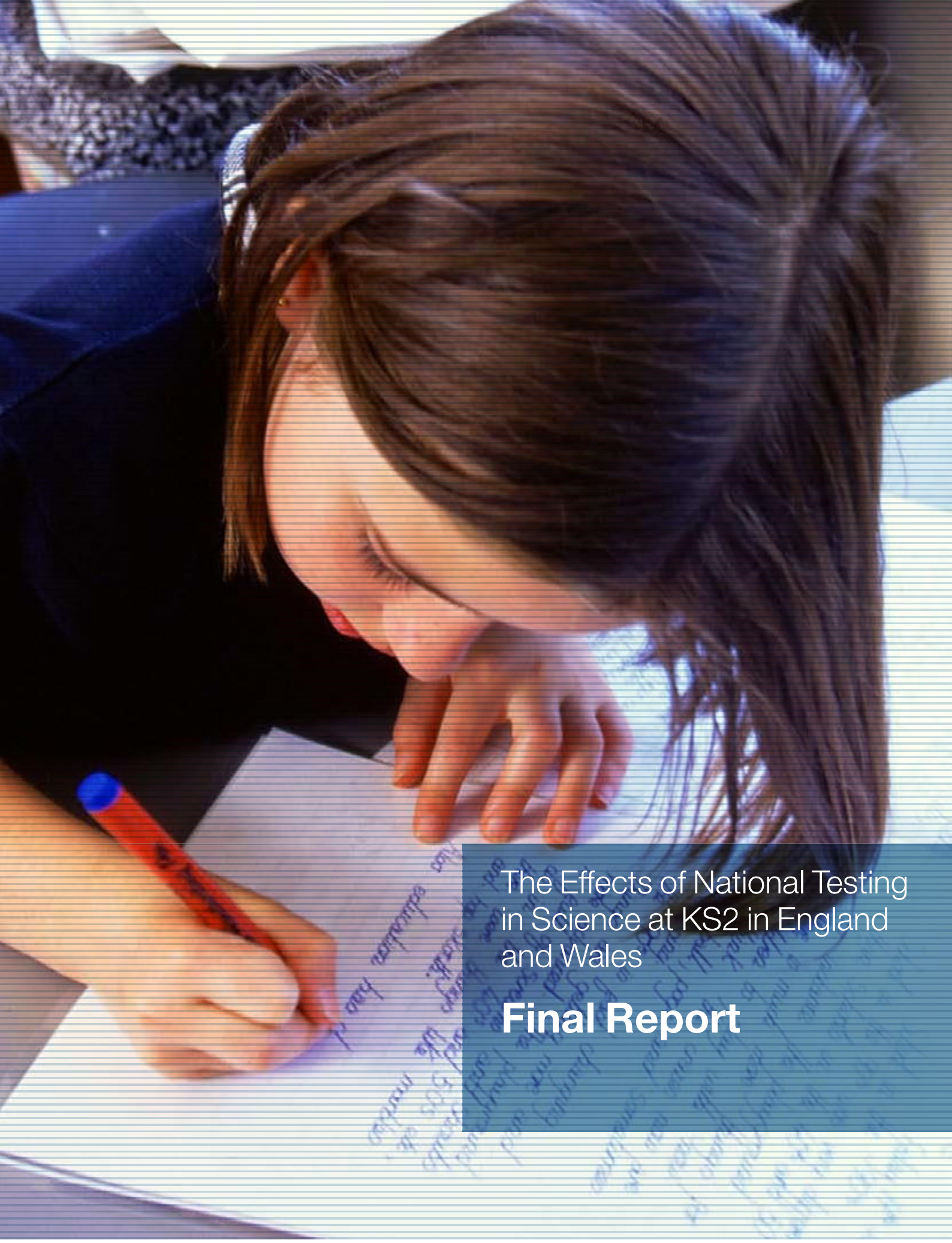

The Effects of National Testing in Science at KS2 in England and Wales

Final Report

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Leading education and social research
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The Effects of National Testing in Science at KS2 in England and Wales

Report

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Commissioned by the Wellcome Trust in association with the ASE

Contents

1.0 Executive summary

Introduction

The research aimed to explore the effects of compulsory national testing in science on Year 6 (Y6) teachers and the teaching of science in England, as well as the impact of the abolition of statutory testing in science at Key Stage 2 (KS2) in 2004 on Y6 teachers and the teaching of science in Wales.

Objectives of the research

The objectives of the present research were to:

- Explore approaches to the teaching of science in England and Wales with an emphasis on assessment of pupils' learning at KS2
- Investigate the impact of changes in end of KS2 assessment in science on teachers and the teaching of science in Wales
- Understand the views of teachers in England and Wales about the strengths and weaknesses of current assessment arrangements
- Understand the views of teachers in England about the value and impact of school and college achievement tables based on test results
- Make recommendations based on research findings to inform changes in assessment procedures and practice in science at KS2 in England and Wales where appropriate.

Research methods

The research methodology was designed to systematically gather and explore a range of views about the teaching of science and the impact of assessment procedures and practices in Y6 in England and Wales.

The research utilised both quantitative and qualitative methods:

- A telephone survey of teachers in England and Wales
- Focus group discussions in England and Wales.

Quantitative research

A telephone survey of 600 teachers, science coordinators and headteachers – 300 from England and 300 from Wales – was conducted by Ipsos MORI in September/October 2007. The telephone survey gathered information about approaches to science teaching in Y6 and views and experiences of assessment procedures and practices used to determine pupils' level of attainment in science at the end of KS2 in England and Wales.

Qualitative research

Eight focus group discussions were conducted – 4 in England and 4 in Wales – involving of a total of 74 Y6 teachers, science coordinators, headteachers and secondary science teachers. Discussions were designed to explore participants' experiences and views of science teaching and assessment of pupils' learning in Y6 and to investigate in greater depth issues arising from the telephone survey.

Conclusions

1. Teaching and learning strategies used for science in Y6

a) The telephone survey revealed markedly similar approaches to teaching and learning in science in Y6 among sub-groups of Y6 teachers, science coordinators and headteachers in England and Wales and across the two countries.

b) Telephone survey responses, confirmed by focus group discussions, provided evidence of an understanding of current thinking about effective teaching and learning strategies for science at KS2, where progression in pupils' knowledge and understanding of science is most effectively achieved through the development of pupils' science process skills.

c) Focus group discussions in England revealed that Y6 teachers utilised a range of teaching strategies found to be effective in supporting revision of the KS2 science curriculum and the development of those aspects of pupils' science knowledge, understanding and skills likely to be included in national test papers.

d) Teachers reported that the pressure of test preparation in Y6 classes in England was not the sole reason for a reduction in time devoted to practical science activities and investigations in Y6 classes; behaviour management issues across KS2 contributed to teachers' reluctance to encourage hands-on science activities in the classroom.

e) There was evidence to show that changes in assessment procedures and processes in Wales were having some impact on approaches to teaching and learning in science in Y6. Released from the need to prepare pupils for national tests, Y6 teachers were able to concentrate on the development of pupils' knowledge and understanding using the National Curriculum *Scientific Enquiry* programme. It was felt this also facilitated summative teacher assessment of the whole of KS2 science.

f) Focus group discussions revealed the growing popularity of Interactive White Boards (IWB) for the teaching of Sc1 in Y6 classes in England and Wales. Sophisticated software provided opportunities for whole class 'virtual' investigations that were pupil-friendly and stimulating. Some Y6 teachers used IWB programmes to elicit pupils' existing ideas at the beginning of science topics and to monitor and assess learning during investigations.

2. Main challenges facing Y6 teachers in the teaching of science in England and Wales

a) The main challenges faced by Y6 teachers in England and Wales were reported to be a lack of time generally for science in Y6 and the need to revise the entire KS2 science curriculum in two terms in preparation for national tests in England and summative teacher assessment in Wales.

b) Teachers in England and Wales maintained that the situation in Y6 was compounded by a lack of classroom support for science, to assist teachers in the general management and organisation of science lessons and, in Wales, to facilitate teacher assessment of group and individual work in science.

c) Headteachers in England expressed concern about the impact of science revision and test preparation on Y6 teachers' attitudes towards science, particularly those lacking in confidence in teaching the subject.
d) The impact of national testing on pupils' attitudes towards science at KS2 was raised as a cause for concern by focus groups of headteachers, Y6 teachers and science coordinators.
e) Particular challenges reported by Y6 teachers in Wales centred on the need for summative teacher assessment for science in Y6, including:
    - Concerns about the accuracy of National Curriculum statements of attainment to inform assessments – despite the provision of optional test materials to support summative judgements
    - A lack of accuracy and consistency in internal and external moderation practices, particularly in determining pupils' levels of attainment in science at KS2.

3. Assessment strategies used for science in Y6

a) Summative assessment strategies used by Y6 teachers in England were said by participants to be selected to provide pupils with support and feedback needed to prepare them for KS2 national science tests.
b) Formative assessment strategies used by Y6 teachers in England and Wales were said to include informing pupils of the learning intentions for science topics and lessons and providing feedback to pupils on their work. Feedback to pupils without marks was utilised in one of two ways:
    1. To inform pupils of their progress on practice tests and to feedforward in offering advice on ways in which performance in tests might be improved, or
    2. To support pupils' learning in science and facilitate teacher assessment for summative purposes.

4. Assessment procedures and practices for science in Y6

a) Participants in focus groups in England maintained that statutory national testing in science at KS2 informed assessment procedures in the following ways:
    - Y6 teachers were left with little option but to devote a considerable amount of time in science lessons to test preparation, particularly in the spring term
    - There was a tendency for Y6 teachers to focus on aspects of science likely to be tested and this resulted in a narrow curriculum for science and fewer opportunities for pupils to undertake science investigations or other practical activities in science in Y6
    - Test preparation in its current form contributed little to pupils' understanding in science. The sole purpose was to equip pupils with sufficient factual knowledge and scientific terminology to answer written questions on science test papers.
b) In Wales optional test materials were used in all Y6 classes in schools represented. However, practice varied in the following ways:

- In a small number of schools optional tests had simply replaced statutory national tests in Y6 as a means of determining pupils' level of attainment in science at KS2
- In other schools optional tests were utilised to inform Y6 teachers' judgements of pupils' level of attainment in science
- The remainder of schools represented used optional test materials to provide supplementary evidence to support summative teacher assessment.

5. Perceived and actual effects of the abolition of national testing for science at KS2

a) Participants in England were generally positive about the potential advantages to teachers and pupils of an abolition of national testing in science at KS2 in favour of summative teacher assessment of pupils' levels of attainment in science. The key benefit was perceived to be an opportunity to integrate science investigations and other practical activities more fully into science lessons throughout the year. However, teachers maintained that the success of such an initiative would largely depend on the quality of internal and external moderation procedures and practices to ensure consistency in the interpretation of levels of attainment within and across schools.

b) Survey respondents and focus group participants in Wales suggested that the abolition of national testing and developments in summative teacher assessment for science at KS2 had positively affected the teaching of science in Y6 classes in primary schools where changes in assessment procedures and practices had been more fully implemented. Freed from the restrictions of test preparation, teachers said they were beginning to utilise a broader range of teaching strategies, encouraged by requirements for summative teacher assessment to include judgements of pupils' levels of attainment in all KS2 National Curriculum programmes of study for science.

c) Headteachers in Wales, while fully supportive of changes in assessment procedures at KS2, called on the Welsh Assembly and local authorities to provide the following:
    - Clear and consistent guidance on summative assessment procedures at KS2
    - Detailed information about the content of the revised KS2 curriculum for science to be implemented in 2008 to inform action plans for continuing professional development for Y6 teachers.

d) Secondary science teachers in England claimed to mistrust KS2 national test results for science. Test scores were said to provide inaccurate information about pupils' actual levels of attainment in science at the end of KS2, necessitating re-testing of pupils during the autumn term of Y7. Participants thought that summative teacher assessment in Y6 had the potential to provide more accurate assessments with the caveat that this was dependent on clear assessment criteria, rigorous moderation procedures and the use of sub-levels in the assessment of pupils' attainment at KS2 to further enhance accuracy.

e) Survey responses provided clear evidence to support findings of other studies that test preparation in England dominates the teaching and learning of science in Y6. Evidence emerged of a strong conviction among respondents in England and Wales that moderated teacher assessment was capable of providing more accurate information about pupils' levels of attainment in science at KS2 than national test scores.

6. Perceptions of links between assessment and standards

a) Participants in England expressed dissatisfaction with the current practice of basing *school and college achievement and attainment tables* (SCAATs) on national test scores for science at KS2. The main reason was the perceived inaccuracy of national tests in determining pupils' levels of attainment in core curriculum subjects at KS2.
b) Following the abolition of SCAATs in Wales in 2004, headteachers had devised alternative strategies to inform parents of Y6 pupils about their child's progress and summative level of attainment in science at KS2. While communication currently involves a relatively lengthy process of parent-teacher discussion and personalised reports, it was said that this provided more accurate information than was previously the case when reporting to parents was based on pupils' national test results.

Recommendations

The following recommendations are informed by the findings of this research.

Recommendations for policy makers

England

1. If national testing in science at KS2 is to be retained, policy makers should explore ways in which assessment might positively promote the development of pupils' understanding in science through the use of process skills in Y6, enabling teachers to utilise a broader range of teaching strategies and approaches to science than is currently the case.
2. Policy makers should evaluate national tests for science. There is a need for consideration of the following:
    - The extent to which preparation for science tests in Y6 classes has the effect of narrowing the science curriculum and limiting opportunities for pupils to engage in practical science work in Y6
    - Ways in which science tests might be developed to ensure that tests access the full range of skills and knowledge that pupils experience in KS2 science.
3. Policy makers should review the appropriateness of the formulation of SCAATs based on national test scores in English, mathematics and science.

Wales

1. Policy makers should consider ways in which assessment procedures and practices, recommended schemes of work and optional test materials for science at KS2 might reflect the importance of teaching strategies such as science from stories, drama/role-play and field trips to enhance the teaching and learning of science in Y6.

England and Wales

1. Policy makers should consider ways in which revision of the entire KS2 science curriculum in Y6 to facilitate summative assessment in science at KS2 might be avoided.
2. An evaluation of levels of classroom support for science in Y6 is needed by policy makers in an effort to assist Y6 teachers in England in undertaking whole class practical science revision sessions and to facilitate summative teacher assessment in Y6 classes in Wales.

Recommendations for further research

England

1. Further research is needed to explore the impact of assessment procedures and practices in science at KS2 on pupils' and teachers' attitudes towards science in Y6.
2. Research on primary-secondary transition should be undertaken to explore the following:
    - Existing good practice in supporting pupils' learning in science during transition from KS2 to KS3, to identify ways in which this might be disseminated
    - Factors that support pupils' learning in science and those which inhibit progression in individual learning and impact on pupils' attitudes towards science during transition between primary and secondary school.

Wales

1. Further research is needed to investigate developments in approaches to teaching and learning of science in Y6. The aim of the research should be to determine the extent to which revised assessment procedures and teaching practices positively promote the use of investigations and practical activities in developing pupils' knowledge and understanding of science at KS2.
2. There is a need for further research to investigate and monitor the development of Welsh Assembly policies and initiatives for assessment in science, with particular reference to internal and external moderation procedures at KS2.
3. There is a need for further research and monitoring of developments in the use of optional test materials for science in Y6 to explore ways in which materials are used to inform or support summative teacher assessment in providing accurate information about pupils' levels of attainment in science at the end of KS2.
4. Further research and monitoring of developments in assessment procedures and practices should be undertaken to explore:
    - Developments in assessment procedures for science at KS2 to identify factors likely to encourage or inhibit change towards the use of summative teacher assessment in science at KS2
    - The revised National Curriculum for science with an emphasis on the extent to which it supports changes in summative assessment procedures and practice at KS2

- Progress in Welsh Assembly guidance to support the development of summative teacher assessment for science at KS2.

5. Further research should be undertaken to explore the nature and effectiveness of procedures introduced to replace SCAATs in informing parents about their child's progress and attainment in science at KS2.

England and Wales:

1. There is a need for further research to explore formative teaching strategies for science used by Y6 teachers in England and Wales. The aim of the research should be to ascertain the purpose of formative strategies used by Y6 teachers and the ways in which they support the development of pupils' knowledge and understanding of science at KS2.

2.0 Introduction

This research explores the effects on Year 6 (Y6) teachers and teaching of summative assessment in science at Key Stage 2 (KS2) in England and Wales and the impact of the abolition of statutory science at KS2 in Wales. The research was undertaken over a five-month period beginning on 1 September 2007.

2.1 Aims and objectives of the research

The research aimed to explore the effects of compulsory national testing in science on Y6 teachers and the teaching of science in England, as well as the impact of the abolition of statutory testing in science at KS2 in 2004 on Y6 teachers and the teaching of science in Wales.

In order to achieve this aim the following objectives were agreed:

- Explore approaches to the teaching of science in England and Wales in Y6 with an emphasis on the assessment of pupils' learning at KS2
- Investigate the impact of changes in end of KS2 assessment in science on teachers and the teaching of science in Wales
- Understand the views of teachers in England and Wales about the strengths and weaknesses of current assessment arrangements
- Understand the views of teachers in England about the value and impact of school and college achievement tables based on test results
- Make recommendations based on research findings to inform changes in assessment procedures and practice in science at KS2 in England and Wales where appropriate.

2.2 Background

An exploration of the impact of statutory national tests on teachers and the teaching of science at KS2 is timely, given the Welsh National Assembly response to arguments that the testing of pupils at age 7, 11 and 14 undervalues the purpose of education, reducing it, at times, to little more than the ongoing preparation for the next battery of statutory tests (DARG, 2004).

The General Teaching Council (GTC) for England recently called for an overhaul of the current testing regime in England (GTC, 2007). This follows the decision by the Welsh National Assembly in 2004 to abolish statutory national assessments that were not well matched to the purposes they should be serving, but led to a narrowing of the curriculum and failed to support pupils during primary-secondary transfer (DARG, 2004; Budge, 2006).

The decision to abolish national testing and associated school and college achievement and attainment tables (SCAAT) in Wales followed an ACCAC (2004) review of curriculum and assessment arrangements in primary and secondary schools[1]. This review, carried out by the Daugherty Assessment Review Group (DARG, 2004) concluded that existing twin track assessment

[1] **Explanatory note:** ACCAC: Awdurdod Cymwysterau Cwricwlwm ac Asesu Cymru is the Welsh equivalent of the Qualifications, Curriculum and Assessment Authority in England. In March 2006 ACCAC merged with the Education Department of the Welsh Assembly Government. In April 2006 ACCAC merged with the Welsh Assembly Government's new Department for Education Lifelong Learning and Skills (DELLS).

procedures of statutory tests and teacher assessments at the end of KS2 caused confusion about the role of each track in the system as a whole and was wasteful of resources. It was therefore decided to phase out end of KS2 tests and from 2005 to base pupils' levels of attainment on the 'best fit' judgement of teachers alone.

Acknowledging the need for skills profiles, including diagnostic skills tests in literacy, numeracy and problem-solving, DARG concluded that Year 5 (Y5: 9-10 years of age) was the optimum time for this rather than Year 6 (Y6: 10-11 years of age) as this would serve to reflect individual skills development during the first three years of KS2 and to inform teachers in Y6 about the needs of individual pupils in the last year of KS2. In addition, evidence of progress during Y6, measured by teacher assessment, would be added to the Y5 skills profile together forming part of the data about attainment to be communicated as each pupil moved into KS3.

However, by the end of 2006 plans for the use of skills tests for 10-year-olds had been abandoned by the Welsh Assembly and skills profiles postponed until 2009/10 in favour of teacher assessments that would be internally and externally moderated to ensure consistency within and between schools. External moderation of summative teacher assessment at KS2 would be a collaborative process, undertaken by groups consisting of advisory teachers, teachers from receiving secondary schools and primary teachers from feeder schools (Thornton, 2006).

During the first nine years of compulsory education in England every pupil is currently tested three times, taking a total of eight sets of tests. For the majority of pupils this might involve as many as 23 separate papers (QCA, 2004). Research conducted for the National Union of Teachers (NUT) found that Y6 teachers spent the equivalent of 4.6 hours each week preparing pupils for National Curriculum tests (NUT, 2003).

A number of recommendations have been made over the past two years concerning ways in which end of Key Stage assessment in England might be reformed to counteract a possible tendency among teachers to prepare pupils for tests resulting in a narrow curriculum and undue pressure on pupils (GTC, 2007). In his speech in 2005 to launch the Qualifications and Curriculum Authority (QCA) *Annual Review*, the Chief Executive, Ken Boston, expressed his confidence in the ability of teachers and schools in England to develop rigorous teacher assessment capable of meeting government requirements (Boston, 2005).

He forecast the replacement of formal national testing with moderated teacher assessment for summative purposes at the end of KS2 and KS3, supported by a bank of suitable test materials from which teachers would be free to choose when individual pupils were deemed ready, but he predicted a ten-year transition period.

In launching *Excellence and Enjoyment: A Strategy for Primary Schools* the Secretary of State for Education, Charles Clarke, set out a vision for the

future of primary education in England, intended to build on what had already been achieved (DfES, 2004). The Primary National Strategy – part of the DfES *Excellence and Enjoyment: Learning and Teaching in the Primary Years* Initiative – has at its centre a desire to improve pupils' learning through the use of formative assessment for learning (AfL), particularly in literacy and mathematics with the aim of optimising pupils' performance in summative statutory tests at the end of KS1 and KS2.

These intentions were confirmed in the consultation document *Making Good Progress* (DfES, 2007), which acknowledged 'the enormous improvements in school standards since 1997' (p. 1), but expressed concern that pupils do not progress equally in their learning and many 'still get left behind' (p. 1). In an effort to enhance pupils' progress the government proposed piloting new approaches to assessment. This process began in 2007 with a pilot involving over 400 schools and 22,500 pupils aged 7-14 years. Teacher assessment of pupils' progress and attainment was supported by single-level tests in English and mathematics taken by pupils when judged by teachers to be ready. The emergence of 'unexpected patterns' in test scores in early 2008 led to a delay in publication of the results. Future intentions, including those for the assessment of pupils' attainment in science at KS2, therefore remain uncertain in England at this time.

2.3 Review of literature

In the absence of research directly related to the effects of national testing on teachers and teaching of science at KS2 in England and Wales, relevant literature scrutinised to inform the present research focused on the purposes of assessment for education and the relative merits and drawbacks of assessment strategies.

Education in England and Wales has long been dominated by systems of summative assessment. A substantial body of research evidence supports the view that such assessments are largely ineffective and possibly detrimental to the provision of quality education for pupils. It is argued that the key reason for this is an interpretation of the purpose of education as the certification of individual learning – summative assessment – and the use of assessments designed for this purpose to provide information about the quality of education offered by the individual school (Gipps *et al.*, 1996; Massey, 1997; Wiliam, 2001; ARG, 2002; Harlen & Deakin-Crick, 2003; Broadfoot & Black, 2004; Moore, 2005; Black & Wiliam, 2006).

Research studies continue to raise questions about the validity and reliability of standardised testing in providing accurate information about pupils' levels of attainment at the end of each Key Stage – an issue of particular importance at KS2 where assessments have the 'high stakes' purposes of evaluation and accountability (Black, 1995, 1998; Schagen & Kerr, 1999; Wiliam, 2001; Newton, 2003). While concluding that a combination of national tests and teacher assessment at KS2 and KS3 represented a valid assessment system, research studies maintain that the use of test results for the purposes of accountability diminish the role of teacher assessment in monitoring pupils' progress, suggesting that it is not the tests themselves that are at issue, but

the accuracy of inferences drawn from them in making decisions about the quality of provision of the individual school (Stobart, 1999).

Several studies conclude that statutory end of Key Stage testing has little to do with pupils' learning and that the potential contribution of formative assessment has been largely neglected (Gipps, 1994; ARG, 1999; Clarke, 2005; Harlen, 2005; Moore, 2005). While teachers are urged to focus teaching and learning on the needs of individual pupils, integrating assessment for learning into classroom practice, they remain under pressure from within and outside school to consistently meet government targets in improving national test results in core curriculum areas with an emphasis on English and mathematics. Such expectations lead Y6 teachers toward transmission teaching with an emphasis on factual knowledge, since this is what is tested, despite evidence to show that such test preparation at KS2 is ineffectual in enhancing pupils' knowledge and understanding in science (Black, 1995; Brown *et al.,* 1996; Clarke, 1996; Ellis, 1997; Wiliam, 2001; Sturman, 2003; Boyle *et al.*, 2004; Boyle *et al.,* 2005).

Recent developments in Wales, where end of Key Stage statutory testing has been abolished in favour of summative teacher assessment and optional test materials, reflect findings that the negative consequences of summative assessment might be minimised by more appropriate use of teacher assessment in forming judgements about pupils' levels of attainment at the end of each Key Stage (e.g. Black & Wiliam, 1998; ARG, 2006)

In considering the specific issue of national testing of science at KS2, there is evidence to show that teachers in secondary schools rarely take account of pupils' previous work in science. Information supplied about pupils' attainments and needs in science, based on teacher assessment as well as national test results, are infrequently utilised to inform planning in secondary schools (Nicholls & Gardner, 1999; Schagen & Kerr, 1999; Braund & Hames, 2005). For this reason attempts have been made to introduce 'bridging units', or 'bridging work' for science, offering opportunities for primary and secondary teachers to collaborate in devising science topics and activities that would span KS2/3 transition (Braund & Hames, 2005).

A full review of literature used to inform the present research can be found in Appendix 1.

2.4 Research methods

The methodology in this study involved two elements which, taken together, provided a range of quantitative and qualitative data collection and analysis. A multi-faceted approach (Cohen *et al.,* 2007) was appropriate for this research as it lends itself well to an exploration of diverse and complex views about challenges faced by Y6 teachers in the teaching of science and of those who support them in primary schools in England and Wales.

Quantitative and qualitative methods utilised for this research were:

- A telephone survey of teachers in England and Wales
- Focus group discussions in England and Wales.

2.4.1 Quantitative research

Telephone survey

A sample of 600 primary Y6 teachers, science coordinators and headteachers participated: 300 from England and 300 from Wales. The first part of the telephone survey instrument, conducted by Ipsos MORI, was designed to gather factual information about assessment procedures and practices in science at the end of KS2 in England and Wales. The remainder of the instrument was designed to collect data relating to respondents' views, attitudes and perceptions of the effects of statutory national testing in science on teachers and the teaching of science in Y6. While the majority of questions were the same for England and Wales to facilitate contrast and comparison of data, two questions relating specifically to assessment procedures in each country were included.

The instrument utilised questions requiring frequency ratings, from *often* to *never* and Likert 5-point scale ratings ranging from *strongly agree* to *strongly disagree.* In addition there were two open questions. In the first of these teachers were invited to identify the main challenges faced by Y6 teachers in the teaching of science in England and Wales. In the second, respondents in England were asked to consider in what ways, if any, the teaching of science in Y6 might change if statutory national testing were abolished in favour of teacher assessment. Teachers in Wales were invited to identify the effects, if any, of the abolition of statutory national testing in science on the teaching of science in Y6 in their school. The questionnaire is appended (Appendix 2).

Data from telephone interviews were coded and returned in ASCII format for analysis by the research team.

The sample characteristics outlining gender, age profile, position in school, length of service, highest qualification in science and time spent on science teaching in Y6 each week are presented in Appendix 3.

2.4.2 Qualitative research

Focus groups

Focus group discussions were designed to develop aspects of the telephone survey instrument. Discussions also aimed to explore in greater depth the experiences, views and opinions of participants of the effects of statutory national testing on Y6 teachers and the teaching of science in England and the effects of the abolition of statutory testing in science in Wales.

Eight focus group discussions were conducted – 4 in England and 4 in Wales – involving a total of 74 Y6 teachers, science coordinators, headteachers and secondary science teachers as follows:

England:

- 2 groups of Y6 teachers and science coordinators (N=25)
- 1 group of primary headteachers (N=8)
- 1 group of secondary science teachers (N=8).

Wales:

- 2 groups of Y6 teachers and science coordinators (N=18)

- 1 group of primary headteachers (N=11)
- 1 group of secondary science teachers (N=4).

All focus group discussions were tape-recorded.

3.0 Research findings

This section of the reports details findings from the telephone survey and focus group discussions in England and Wales.

3.1 Teaching strategies and the development of science process skills

> *You try to make sure they do the practical stuff in Y3 and Y4, because there's no chance they'll do it in Y6.* (Science coordinator – England)
>
> *We do hands-on science lessons for every topic; we really push investigations and fair testing …* (Y6 teacher – Wales)

The present research explored the nature and range of strategies used by teachers in the teaching of science in Y6 classrooms in England and Wales. The telephone survey was used to gain a broad view of teaching strategies and approaches used in the teaching of science in Y6. Focus group discussions were designed to gain insight into the reasons why teachers utilised different teaching strategies and approaches in the teaching of a 'typical' science lesson in Y6.

3.1.2 Telephone survey: teaching strategies

Analysis of telephone survey responses provided clear evidence of an understanding among Y6 teachers, science coordinators and headteachers in England and Wales of the importance of the Science National Curriculum *Scientific Enquiry* (Sc1) programme of study as a means of developing pupils' knowledge and understanding of science at KS2 (e.g. Tobin *et al.,* 1990; Feasey, 1993; Stohr-Hunt, 1996; Harlen, 1999).

There were no significant differences in the nature of teaching strategies teachers reported using *often* or *sometimes* in the teaching of science in Y6 in England and Wales (Figure 1). In all Y6 classes represented in the telephone survey in England and Wales, pupils were engaged in at least some hands-on science activities during the year, including investigations or other kinds of practical work. The rank order of combined frequency of use of teaching strategies reported by teachers in England and Wales were:

- Practical work other than science investigations (100%)
- Science investigations (99%)
- Relating science to everyday life (99%)
- Whole class discussions (99%)
- Group discussions (99%)
- Developing thinking skills (97%)
- Teacher demonstrations (93%)
- Integrating science with other subjects (91%)
- Field trips (63%)
- Teaching science from stories (46%)

- Teaching science through drama and role-play (40%).

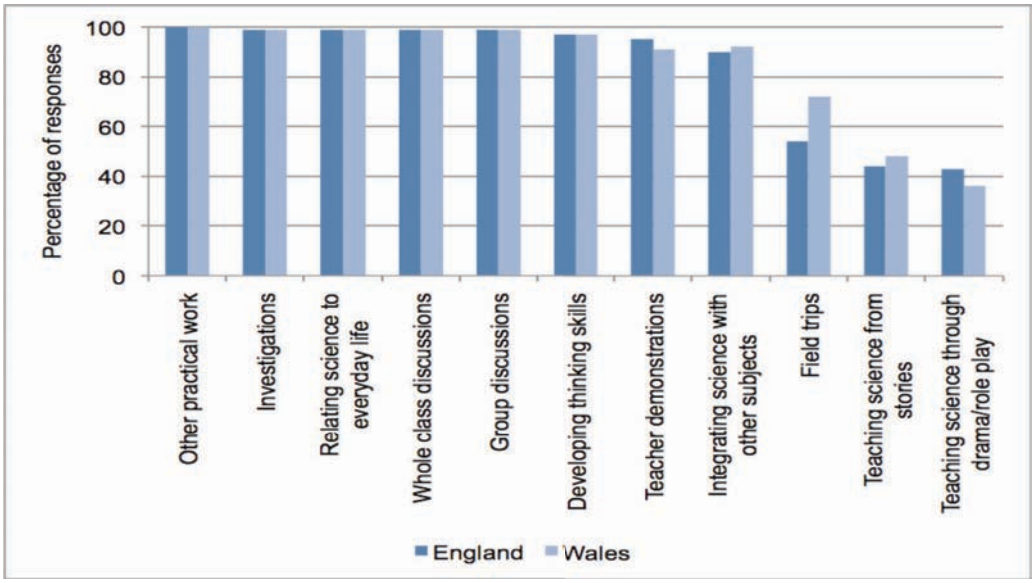

Figure 1 Telephone survey findings in England and Wales: Teaching strategies and approaches to science in Y6 used *often* or *sometimes*

3.1.3 Telephone survey: development of science process skills as a means to understanding in science

Respondents to the telephone survey in England and Wales were asked to rate on a four-point scale the frequency with which listed science process skills formed part of pupils' learning in science in Y6.

Responses of Y6 teachers, science coordinators and headteachers in England and Wales (Figure 2) demonstrated a strong commitment to the development of pupils' science process skills as a means to developing pupils' understanding of science in Y6. There were no significant variations in the frequency with which respondents in England and Wales *often* or *sometimes* integrated process skills into science lessons in Y6.

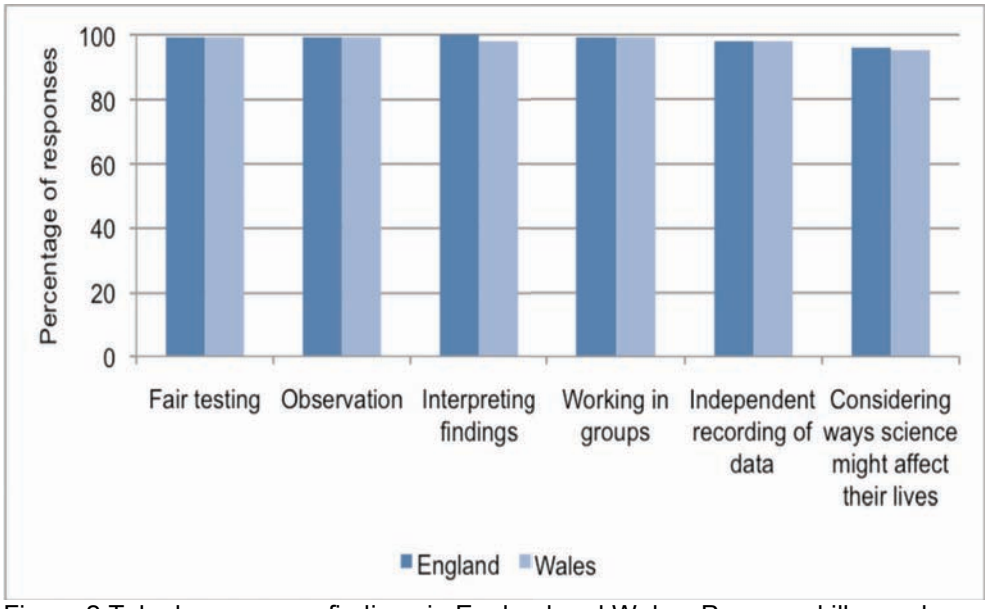

Figure 2 Telephone survey findings in England and Wales: Process skills used to inform pupils' learning in science in Y6

The rank order of combined frequency with which process skills underpinned pupils' learning in science in Y6 in England and Wales included:

- Recognising, designing and carrying out a fair test (99%)
- Observation (99%)
- Interpreting findings (99%)
- Working in groups (99%)
- Independent recording of data (98%)
- Considering ways in which science might affect their everyday lives (95%).

3.1.4 Focus group discussions: teaching strategies and the development of science process skills

In focus group discussions involving Y6 teachers and primary science coordinators in England and Wales the telephone survey questions, *teaching strategies used for science* and *development of science process skills,* were conjoined as groups were encouraged to discuss a 'typical' science lesson in Y6. Throughout the discussion Y6 teachers were encouraged to consider personal practice and experience while science coordinators reflected on recommendations and support offered to Y6 teachers in developing effective teaching and learning strategies for science.

The substance of discussions in England and Wales were sufficiently different to warrant reporting findings separately.

3.1.4.1 England

Teaching strategies and pupils' experiences of science in Y6 varied greatly in England according to the time of year. Investigations and practical work in science were the norm in the majority of schools represented during the autumn term, but revision and preparation for national statutory tests for English, mathematics and science took precedence in the spring term effectively eliminating investigatory and other practical science activities.

Despite enjoying relative freedom from direct test preparation in the autumn term Y6 teachers identified teaching strategies that reflected the need for revision of the entire KS2 science curriculum in Y6 prior to national testing, explained by the following exchange:

> The children can't retain everything they need to know for SATs over three years. It's not the same as English and maths where they sort of build on the concepts all the way through … (EY6/SC1a)[2]

> Yeah, we are not building on things that have gone before – it's segmented in a way that English and maths aren't. (EY6/SC1b)

Although it was clear that Y6 teachers in both focus groups in England felt under considerable pressure to revise all major aspects of the KS2 science curriculum, this was only insofar as it enabled pupils to answer test questions, which since 2005 have included questions related to designing and conducting investigations. Participants confirmed research findings in openly acknowledging that the impetus for revision in Y6 was test preparation rather than consolidation of pupils' knowledge, understanding and skills of science (Hopkins, 2003; Sturman, 2003; Boyle *et al.,* 2005). As one teacher explained:

> In a typical lesson you've got your priorities, you've got to get through electricity, you've got to get through magnetism, you've got all your resources laid out and you're rushing them. You say, 'You've started a really good investigation there, but stop now, you've done all you need to do on this', so you're closing them down all the time. (EY6/SC1c)

There was considerable support for the view that all aspects of practical science in Y6 were teacher directed, structured and focused only on what was needed to correctly answer test questions. Opportunities for pupils to extend, test or develop their ideas and understanding through investigations or other practical work in science were routinely curtailed. As one science coordinator explained:

> You try to make sure they do the practical stuff in Y3 and Y4, because there's no chance they'll do it in Y6. (EY6/SC2a)

Subsequent discussion in this group raised questions about the above statement and about the extent to which teaching strategies for science in Y6 were dictated entirely by the need for revision. One teacher gained strong support for his claim that even if there was more time and freedom in Y6 it was *'unlikely'* that he would include more investigative and practical activities in science sessions. As he explained:

> In my class I wouldn't dream of doing a whole class practical science lesson. I have too many behaviour problems in my class and I have 30 kids and no support. (LY6/SC2b)

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[2] Focus group coding: E or W denotes England or Wales; Y6/SC denotes the sub-group of Y6 teachers and primary science coordinators; 1 or 2 denotes the first or second focus group in the country and the lower case letter signals which participant is speaking.

Issues of behaviour management and lack of class-based support for science were said by teachers from both focus groups to influence decisions about appropriate teaching strategies for science. A small number of science coordinators expressed concern about a lack of time available to offer support for teachers in Y6 and throughout KS2 since the implementation of the Workforce Agreement, which reportedly reduced the amount of time for some coordinators to spend with teachers on in-class support and professional development. This was an important issues for three science coordinators who expressed serious concerns about the level of support available for more recently qualified teachers who were judged by one coordinator to have *'inadequate science knowledge and confidence'*, and were '*frightened to teach in KS2 where children play up and ask awkward questions'* (EY6/SC2c).

Participants across groups confirmed findings of the telephone survey in reporting that *drama and role-play* and *science from stories* were the least frequently deployed teaching strategies in science sessions in Y6. Time constraints were cited as the main justification, though there was agreement among one group of Y6 teachers and science coordinators of the particular benefits of drama and role-play for pupils with English as an Additional Language (EAL) and Special Educational Needs (SEN), to aid pupil understanding through active involvement in science lessons, but as one teacher put it:

> Time is the enemy of drama and creativity generally in science. (EY6/SC1d)

Participants reported that activities such as *field trips* and *input from science consultants*, while used in other year groups in the majority of schools to enhance teaching and learning in science, did not feature among teaching strategies utilised by Y6 teachers. This finding does not reflect that of the telephone survey where 58% of respondents in England and 72% in Wales reported that field trips were *often* or *sometimes* utilised for teaching science in Y6.

Strategies used by Y6 teachers and recommended by science coordinators to develop pupils' science process skills as a means to understanding in science were elicited through discussions of the need for pupils to demonstrate an ability to plan an investigation as part of science tests at KS2. This requirement, introduced in 2005, has led to the increased use of Interactive White Boards (IWBs) in Y6 to enable teachers to revise relevant aspects of Sc1 without the need for time-consuming practical science activities and investigations in Y6. Over half of all participants in both groups were enthusiastic in their praise of sophisticated software programmes that positively encouraged interactive whole class science investigations. Participants who were familiar with such software were impressed by the quality of graphics to support visual learners. They maintained that pupils utilised and developed skills of prediction and observation as virtual investigations were conducted.

Teachers described science lessons in which the IWB was used to encourage whole class and paired discussion and where pupils were actively involved in each stage of the virtual investigation as their decisions and actions on the

IWB affected the outcome of the investigation. The IWB software discussed by groups was widely available to download and participants who had not previously encountered it were eager to take down details of websites and DVDs. The value of such interactive teaching aids to Y6 teachers was summed up as follows:

> It shows you how to design, plan and set up an investigation and that's what the children need for SATs. They loved the one on dissolving, it's interactive, they control the temperature of the water and the number of stirs of the little spoon … (EY6/SC2e)

Participants who had used interactive programmes for science in Y6 claimed they supported teacher assessment as it was possible to monitor individual pupil responses, and to challenge and explore pupils' existing and developing ideas through questioning and discussion as the class worked through the programme.

A small number of teachers in both groups reported that practical science activities were reintroduced in the summer term following national testing in Y6. However, none of the participants were familiar with bridging units for science, intended to support continuity and progression in pupils' learning during primary-secondary transition as part of the *National KS3 Strategy* (DfES, 2000). Four teachers in one group reported that they set aside time in the summer term to revisit aspects of science tests found difficult or confusing by pupils, utilising practical activities or pupil-led investigations to reinforce pupils' understanding. However, the majority of Y6 teachers did not include science in the timetable once national statutory testing was completed. As one teacher explained:

> The children have worked so hard we only cover the English and maths bridging units and then we do non-SATs related things such as drama and art. (EY6/SC1d)

3.1.4.2 Wales

Teaching strategies adopted by Y6 teachers in Wales were dictated by the extent to which primary schools represented in focus groups had moved towards the use of teacher assessment for summative purposes at KS2.

Although all schools used optional test materials for science at KS2, systems of assessment varied widely among those represented. Procedures and practices fell into three categories:

- Category 1: Summative teacher assessment with externally marked optional tests
- Category 2: Summative teacher assessment informed by internally marked optional tests
- Category 3: Summative teacher assessment supported by optional test materials to provide additional evidence.

Participants from schools in Category 1 identified similar teaching strategies for science as those discussed by Y6 teachers in England, with a focus on revision, teacher-led science sessions and teacher demonstration to support preparation for tests in the spring term. Participants from schools in Category

2 and Category 3 reported a stronger emphasis on practical science activities and investigatory work throughout Y6. As one teacher put it:

> We do hands-on science lessons for every topic; we really push investigations and fair testing. It's part of the whole teaching in science from early in Key Stage 1, only now it goes through all the way to Y6 instead of stopping in Y5 to make way for SATs. (WY6/SC1a)

Participants were supported in the development of teaching strategies to promote practical science activities and investigations through the *Cardiff Effective Learning In Primary Science* (CELIPS) scheme of work, devised by the Local Authority Advisory Team for science and used to a greater or lesser degree by schools represented in this research. The CELIPS scheme encourages a structured, staged approach to science teaching in Y6; each topic follows the same pattern of *engage, explore, challenge, apply* and *reflect.* Although one Y6 teacher used the CELIPS scheme for all science sessions, the majority of participants preferred to use/recommend some topics, or parts of topics, from the scheme and to develop these according to the interests and needs of pupils.

Following the abolition of national testing, participants reported a *'sense of freedom'* in determining their own strategies for science teaching informed by pupils' interests and needs rather than the demands of test preparation.

Teachers regarded the use of teaching strategies such as investigations, practical activities and discussion – both whole class and small group discussion – as vital in informing teacher assessment. Throughout this aspect of the discussion, participants demonstrated positive attitudes towards changes in teaching strategies made possible by the abolition of national testing in science at KS2, illustrated by the following exchange:

> … it's good for teacher assessment because you can see how the children interpret the question and how they plan and go about setting up their investigations after they've had the initial input … (WY6/SC2c)

> … and it's good for mixed ability groups, they can support one another but you can still assess the individual child. (WY6/SC2d)

However, participants in both groups maintained that some science topics in Y6 do not lend themselves as well as others to practical or investigatory work and this had implications for teacher assessment. One such topic was '*Solids, Liquids and Gases'* where health and safety regulations, combined with a lack of classroom support, made it impossible for teachers to confidently instigate practical activities in the classroom. To overcome this, teachers were turning to the Interactive White Board (IWB) and associated science software to support teaching and learning. As one teacher explained:

> When you can't do the practicals the White Board is so much better for the children than just watching a teacher demonstration. (WY6/SC1b)

However, as was the case for teachers in England, the use of the IWB was not restricted to those aspects of KS2 science considered unsuitable for practical or investigative work in the classroom. One Y6 teacher claimed that

IWB technology was more powerful than a simple substitute for teacher demonstration; it had the potential to support the elicitation of pupils' existing ideas at the beginning of a topic. He offered the following example:

> I use the *Crocodile Clips* software for electricity. It's an interactive programme and I use it as a starter lesson to see what the children remember and where the weaknesses are before we then do some practical work. (WY6/SC1c)

Although other participants in this group stressed the importance of hands-on exploration for pupils in topics such as '*Electricity',* a case was made for the wider application of IWB programmes to support pupils with learning difficulties, or those who found manipulation of materials problematic, for instance:

> … some children have real problems joining up circuits and then they reach the wrong conclusions because they can't make it all work. (WY6/SC1d)

Discussion about the use of the IWB for science teaching was lively in both groups; it was clear that the majority of Y6 teachers and science coordinators were either already committed to its use or keen to explore its potential for the teaching and learning of science in the near future. The following comments reflect a broader view of the value of IWB technology for science teaching in Y6:

> I think in science you have to be very aware of what you are asking them to do. You have to lead them in the correct direction and you have to be there going round every group because it's so easy for children to misunderstand or lose their way. And the only way they are going to get any benefit out of Sc1 is proper supervision and correct questioning, so Sc1 isn't always the best way forward, sometimes the White Board makes it clearer. (WY6/SC1e)

> I agree with that. I'm very aware myself that I learned better in science by watching something visual rather than doing it myself, so I'm very aware that some children will get it from practical and some from visual and then some get it from discussion as well and that is very important in science too. (WY6/SC1f)

3.1.5 Conclusions and recommendations

Conclusions

The telephone survey revealed markedly similar approaches to teaching and learning in science in Y6 among sub-groups of Y6 teachers, science coordinators and headteachers in England and Wales and among respondents in both countries.

Telephone survey responses, confirmed by focus group discussions, provided evidence of an understanding among primary teachers and headteachers of current thinking about effective teaching and learning in science at KS2, where progression in pupils' knowledge and understanding of science is most effectively achieved through the development of pupils' science process skills (e.g. Driver, 1988; Feasey, 1993; Harlen, 2000).

Nonetheless, focus group discussions in England revealed that teachers utilised a range of teaching strategies found to be effective in supporting revision of the KS2 science curriculum and the development of those aspects

of pupils' science knowledge, understanding and skills likely to be included in national test papers. Issues of revision and test preparation are discussed in detail in Section 3.3 as these were reported as presenting particular challenges for Y6 teachers in England.

Teachers reported that the pressure of test preparation in Y6 classes in England was not the sole reason for a reduction in the number of practical science activities and investigations in Y6; behaviour management issues across KS2 contributed to teachers' reluctance to encourage hands-on science activities in the classroom.

Optional test materials for science were used to inform, support or confirm summative teacher assessment in Y6 classes of all schools contributing to this research in Wales. However, there was evidence to show that changes in assessment procedures and processes in Wales were having at least some impact on approaches to teaching and learning in science in Y6. Released from the need to prepare pupils for national tests, Y6 teachers were able to concentrate on the development of pupils' knowledge and understanding using the *Scientific Enquiry* component of the programme of study to underpin science lessons on a regular basis to facilitate summative teacher assessment of the whole KS2 science programme of study.

Focus group discussions revealed a growing popularity of Interactive White Boards for the teaching of Sc1 in Y6 classes in England and Wales. Sophisticated software provided opportunities for whole class 'virtual' investigations that were pupil-friendly and stimulating, enabled teachers to elicit pupils' existing ideas at the beginning of science topics and monitor and assess learning during investigations. They helped to address issues of classroom control during practical science sessions and they supported the learning of individual pupils who experienced difficulties in manipulating science materials in investigations.

Recommendations

England: If national testing in science at KS2 is to be retained, policy makers should explore ways in which assessment might positively promote the development of pupils' understanding in science through the use of process skills in Y6, enabling teachers to utilise a broader range of teaching strategies and approaches to science than is currently the case.

Wales: Policy makers should consider ways in which assessment procedures and practices, recommended schemes of work and optional test materials for science at KS2 might reflect the importance of teaching strategies such as science from stories, drama/role-play and field trips to enhance the teaching and learning of science in Y6.

Wales: Further research is needed to investigate developments in approaches to teaching and learning of science in Y6. The aim of the research should be to determine the extent to which revised assessment procedures and teaching practices positively promote the use of investigations and practical activities in developing pupils' knowledge and understanding of science at KS2.

3.2 Main challenges facing Y6 teachers in teaching science

> *I can hear myself going on and on not giving them a chance to talk about anything except to answer the occasional question – that's not what I call teaching.* (Y6 teacher in England describing a typical science lesson)

> *… we need to have evidence to show for everything, to back up our assessments; the high schools want evidence.* (Y6 teacher – Wales)

The telephone survey presented respondents with an open question, inviting individual Y6 teachers, science coordinators and headteachers in England and Wales to identify the main challenges facing Y6 teachers in teaching science.

In an effort to gain insight into the nature and possible underlying causes of challenges faced by Y6 teachers in teaching science, the same question was posed during all focus group discussions in England and Wales.

3.2.1 Telephone survey

Respondents identified a total of twenty-nine aspects of teaching and learning science in Y6 in England and Wales rated as challenging by respondents. Aspects of science teaching found challenging by 10% or more of respondents in England and Wales (Figure 4) included:

- A lack of resources, particularly class-based support during science sessions (34%)
- A lack of time for science in Y6 (23%).

Within the more general category of *lack of resources*, an absence of adequate classroom support for science in Y6 was identified by 40% of respondents in Wales and 28% in England. Few respondents clarified their answers to this question, though two Y6 teachers in Wales made the point that:

> Class numbers are large in Wales and there is lack of support. With large class numbers it's hard to help all pupils at the same time. (TSW1)[3]

> Large class numbers and no support. Trying to do practical work with a class of over thirty children and one adult is a problem and lack of equipment and not having enough time for teaching on a one to one basis. (TSW2)

[3] TSW coding used to denote Telephone Survey Wales. TSE coding used to denote Telephone Survey England. The number following the code identifies a quote from a new respondent.

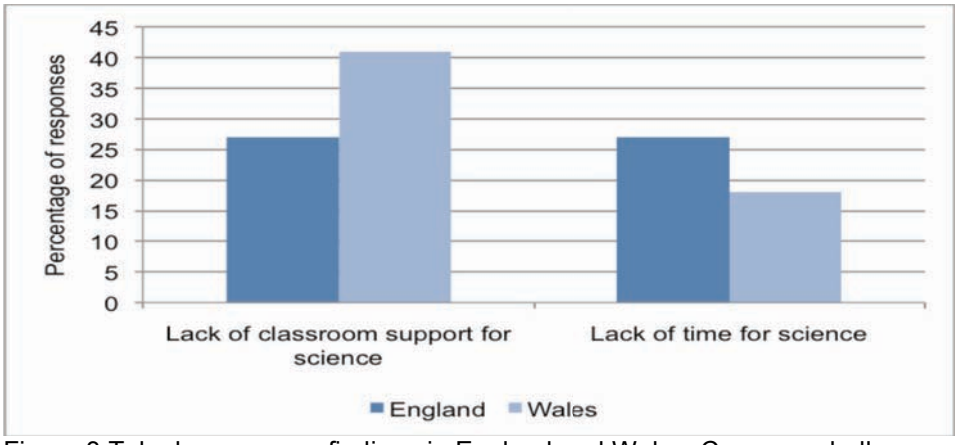

Figure 3 Telephone survey findings in England and Wales: Common challenges faced by Y6 teachers in teaching science

Respondents in England (27%) and Wales (19%) expressed anxiety about the *lack of time* available in Y6 to complete all necessary revision topics in science in Y6 – respondents referred to *'difficulties of fitting all the topics into the time available'* (TSW4) and to *'pressure of time to revise all the topics for SATs'* (TSE1), while others expressed *'fear of not covering all the topics in the time before SATs'* (TSE5).

The challenge of *test preparation* in science was identified by 28% of respondents in England as presenting the greatest challenge for Y6 teachers, illustrated by the following comments:

> The SATs because in Y6 children are having to revise for them and children lose the pleasure and fun they should get from science. (TSE2)

> Managing to maintain a balanced curriculum, there is too much time spent on cramming for SATs, there is less time for teaching arts such as music, painting, drama. (TSE2)

3.2.2 Focus groups

Discussion of the main challenges facing Y6 teachers in the teaching of science was included in the focus group schedule for headteachers in England and Wales as well as for Y6 teachers and science coordinator groups. The inclusion of headteachers in this aspect of the discussion was designed to extend the perspective on the perceived challenges faced by Y6 teachers in the teaching of science in their school.

Issues of classroom support for science were highlighted by focus group participants in relation to teaching strategies and approaches to science in Y6, discussed in Section 3.1. This discussion confirmed telephone survey findings that lack of classroom support for science was an issue of widespread concern for Y6 teachers, science coordinators and headteachers in England and Wales.

Other key challenges for Y6 teachers in the teaching of science in Y6 that were raised in focus group discussions differed between the two countries.

England

As Y6 teachers and science coordinators cited the need for revision and test preparation as a contributory factor in the selection of strategies for teaching and learning in science, it was perhaps not surprising that they identified the need for revision of the entire KS2 science curriculum in the first two terms of Y6 as the greatest challenge for Y6 teachers.

Participants complained of taking pupils on a '*whistle-stop tour'* of topics, which dictated the use of teaching strategies that were at odds with their understanding of the ways pupils learn in science, for example:

> I can hear myself just going on and on not giving them a chance to talk about anything except to answer the occasional question – it's not what I call teaching. (EY6/SC1d)

There was a perception among Y6 teachers and science coordinators that the spiral curriculum, while supporting progression in pupils' learning at KS2 in English and mathematics, was less effective in science where discrete topics did not support progression in pupils' learning as effectively as in the other core subjects. As one Y6 teacher explained:

> They won't have done anything on teeth since Y3, so by Y6 they have completely forgotten the important bits and they only have the occasional words, not the proper vocabulary for it. (EY6/SC2f)

However, this was not to suggest that there was no progression in the science curriculum at KS2. Participants, including headteachers, were eager to stress that revision for science in Y6 did not simply entail repeating topics from other years; progression was also required to prepare them for science tests and this presented very real challenges for Y6 teachers.

Although headteachers expressed concern about the pressures of science revision on Y6 teachers, their priorities for KS2 centred on pupils' attainment in English and mathematics to the detriment of science. As a result Y6 teachers and pupils found it necessary to *'catch-up in science'* in readiness for national science tests. One headteacher helped to clarify the issue in explaining:

> Staff take their lead from the head in terms of their priorities and in my school those priorities have been English and maths in KS2 at the expense of science. The upshot is that Y6 teachers have a lot of ground to make up. I'm also aware that there is less emphasis on practical work in other year groups and children are missing out on science right through KS2 at the moment. (EHa)[4]

Headteachers felt that pressures of revision in Y6 impacted on teachers' and pupils' attitudes toward science. Teachers – particularly those less confident about teaching science – found it difficult to *'maintain any momentum, motivation or enthusiasm for science'* (EHb), and pupils were *'turned off science'*. Despite their evident concern, headteachers were adamant that government targets for English and mathematics at KS2 would continue to inform the priorities of primary headteachers in England.

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[4] EH denotes England Headteachers. The added lowercase letter denotes different participants.

Participants in both Y6/science coordinator groups discussed the challenges of maintaining positive attitudes towards science among Y6 pupils. Pupils entered Y6 with generally positive attitudes, but test preparation coupled with transmission teaching had the effect of *'turning a lot of children off science, they end up groaning when you mention it'* (EY6/SC1e). However, there were exceptions as one Y6 teacher explained:

> It's not like that for all of them though. Some have low attainment levels in tests at the beginning of the year and then they see their levels rising as we go through the tests and that is pretty motivating for some kids. (EY6/SC1f)

Wales

The need for summative teacher assessment, supported by optional tests, of pupils' level of attainment in science at KS2 necessitated revision of the KS2 science curriculum in Y6 in Wales. However, released from the pressure of preparation for national testing in science, revision was more manageable. As one participant explained:

> We still revise all the topics for KS2, but we can take them a bit further now that we don't have to cram them for SATs; there's more time for hands-on science and the children like that. (WY6/SC1b)

As test results no longer formed the basis of published school and college achievement and attainment tables (SCAATs) at KS2 in Wales, the attitudes of teachers and science coordinators towards revision and science testing had altered. As one science coordinator explained:

> In our school we have always put a lot of store by our fantastic results for science. Now the tests are officially optional but we still do them because we want to do well for our own sake. But because they have lost a bit of their importance we still revise in Y6 but we don't cram so much any more – we spread the revision out over the year. (WY6/SC2e)

Optional test materials for science at KS2 had retained a focus on scientific terminology and vocabulary associated with national tests and this presented challenges for a number of Y6 teachers working in Cardiff schools where there are high numbers of pupils with English as an Additional Language (EAL) who struggled with the language of science at KS2.

A small number of participants expressed difficulty in formulating summative judgements of pupils' level of attainment in science based on National Curriculum *Statements of Attainment*, some of which were described as *'woolly'* and open to interpretation. Headteachers supported this view in maintaining that current procedures for summative teacher assessment at KS2 were problematic due to the absence of clear and centrally agreed criteria for teacher assessment across Wales. National Curriculum criteria were considered inadequate as were levels of progression and assessment criteria provided by the Local Authority and the Welsh Assembly (ACCAC). A number of Y6 teachers and science coordinators commented on a sharp increase in Y6 teachers' workloads as a direct result of changes in

assessment procedures and practice at KS2. One participant described a workload that was *'onerous'* in Y6, and another explained:

> The demands on Y6 teachers are greater than for any other year because we need to have evidence to show for everything, to back up our assessments; the high schools want evidence. (WY6/SC2g)

Others found the process of internal and external moderation of summative teacher assessment challenging due mainly to a lack of consistency in the levelling of pupils' work in science across classes and clusters of schools. One Y6 teacher explained:

> We've had some cluster meetings now and they show that there is not consistency in our levelling across our cluster and in the high school as well. We all levelled a piece of work and only 23% of people came up with the same level and that's quite a low percentage. (WY6/SC2h)

A lack of classroom support during science sessions in Y6 presented challenges for the majority of teachers in both groups. Participants reported that it was now necessary for teachers to form summative judgements about pupils' attainment in each strand of the science National Curriculum, including Sc1. Therefore a lack of adult classroom support was an issue of some concern as effective summative teacher assessment was said to be dependent on Y6 teachers having the freedom and flexibility to work with small groups and individual pupils during science sessions.

Headteachers were aware of teachers' concerns, though staff shortages and issues of funding made it difficult to provide the support needed by Y6 teachers. However, they agreed that effective teacher assessment, particularly in relation to pupils' attainment in Sc1, presented particular challenges. As one headteacher put it:

> You can use written work to assess the other strands, but if you rely solely on written work to assess learning, to assess Sc1, you don't really know whose work it is because practical science in our school is always group work. (WHa)

3.2.3 Conclusions and recommendations

Conclusions

Focus group discussions supported the findings of the telephone survey in confirming that the main challenges faced by Y6 teachers were lack of time generally for science and the need to revise the entire KS2 science curriculum in two terms in preparation for national tests in England and summative teacher assessment in Wales.

Teachers in England and Wales maintained that the situation in Y6 was compounded by a lack of classroom support for science, to assist teachers in the general management and organisation of science lessons and in Wales, to facilitate teacher assessment of group and individual work in science.

Headteachers in England expressed concern about the impact of science revision and test preparation on Y6 teachers' attitudes towards science, particularly those who lacked confidence in teaching the subject.

The impact of national testing on pupils' attitudes towards science at KS2 was raised as a cause for concern by focus groups of headteachers, Y6 teachers and science coordinators.

Particular challenges reported by Y6 teachers in Wales centred on the need for summative teacher assessment for science in Y6, including:

- Concerns about the accuracy of National Curriculum statements of attainment to inform assessments – despite the provision of optional test materials to support summative judgements
- A lack of accuracy and consistency in internal and external moderation, particularly in determining pupils' levels of attainment in science at KS2.

Recommendations

England and Wales: Policy makers should consider ways in which revision of the entire KS2 science curriculum in Y6 to facilitate summative assessment in science at KS2 might be avoided.

England and Wales: An evaluation of levels of classroom support for science in Y6 is needed by policy makers in an effort to assist Y6 teachers in England in undertaking whole class practical science revision sessions and to facilitate summative teacher assessment in Y6 classes in Wales.

England: Further research is needed to explore the impact of assessment procedures and practices in science at KS2 on pupils' and teachers' attitudes towards science.

Wales: There is a need for further research to investigate and monitor the development of Welsh Assembly policies and initiatives for assessment in science, with particular reference to internal and external moderation procedures at KS2.

3.3 Assessment strategies for science used in Y6 classes in England and Wales

Y6 teachers in England adopted summative and formative assessment strategies designed to support and prepare pupils for statutory national tests in science.

Y6 teachers in Wales utilised assessment strategies designed to support pupils' understanding in science and facilitate summative teacher assessment.

(Findings from telephone survey – England and Wales)

Telephone survey questions sought to elicit assessment strategies – formative and summative – used by Y6 teachers in England and Wales. Respondents were asked to identify commonly used strategies from the list provided.

England: Summative assessment strategies for science in Y6
Summative assessment strategies used in Y6 (Figure 4) were clearly informed by the need for preparation for national science tests as they included:

- Past SATs papers (97%)
- Teacher review of assessed work in science (95%)
- Practice papers from commercially published schemes of work (72%)
- Checklists to record observations of pupils (61%)
- School-based written tests (51%).

There were no significant differences in responses between sub-groups in England.

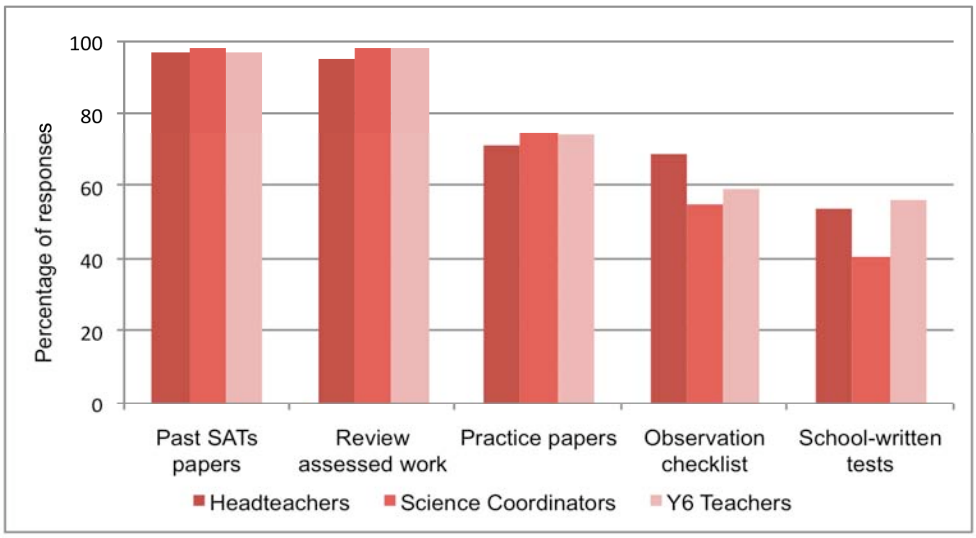

Figure 4 England: Summative assessment strategies for Y6 science

Wales: summative assessment strategies for science in Y6
Respondents to the telephone survey in Wales were offered the same list of summative assessment strategies from which to identify those most commonly used or recommended for the teaching of science in Y6.

A somewhat different picture emerged in Wales (Figure 5). Commonly used strategies included:

- Teacher review of assessed work (95%)
- Past SATs papers (63%)
- Checklists to record observations of pupils (63%)
- School-based written tests (61%)
- Practice papers from published schemes (56%).

Differences in responses between sub-groups of headteachers, science coordinators and Y6 teachers might be taken to reflect changes in end of KS2 assessment procedures in Wales. This would seem to be the case in considering the overall importance of *teacher review of assessed work* to support teacher assessment in Y6.

Differences between the two countries reflected, to some extent, assessment procedures and practices in England and Wales. In England an emphasis on practice papers and past tests might be expected as a means of preparing pupils for national science tests in Y6. However, in Wales, despite a strong emphasis on *teacher review of assessed work* in science, there remained a significant percentage of teachers and headteachers from schools where test preparation strategies continued to form part of summative assessment procedures in Y6.

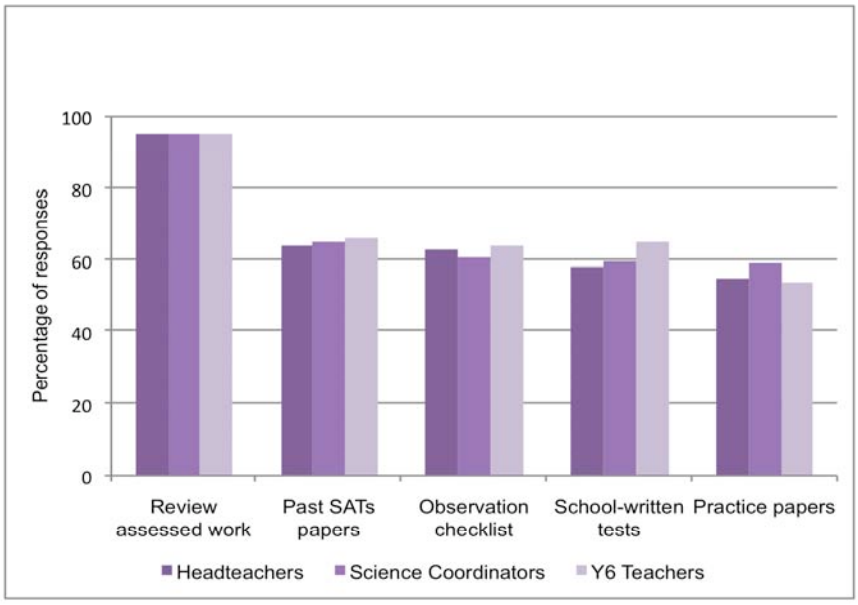

Figure 5 Wales: Summative assessment strategies for Y6 science

England and Wales: Formative assessment strategies for Y6 science

Telephone survey respondents in England and Wales were asked to identify from a list of five typical formative assessment strategies those most commonly used in the teaching of science in Y6. Findings showed no significant difference between England and Wales (Figure 6).

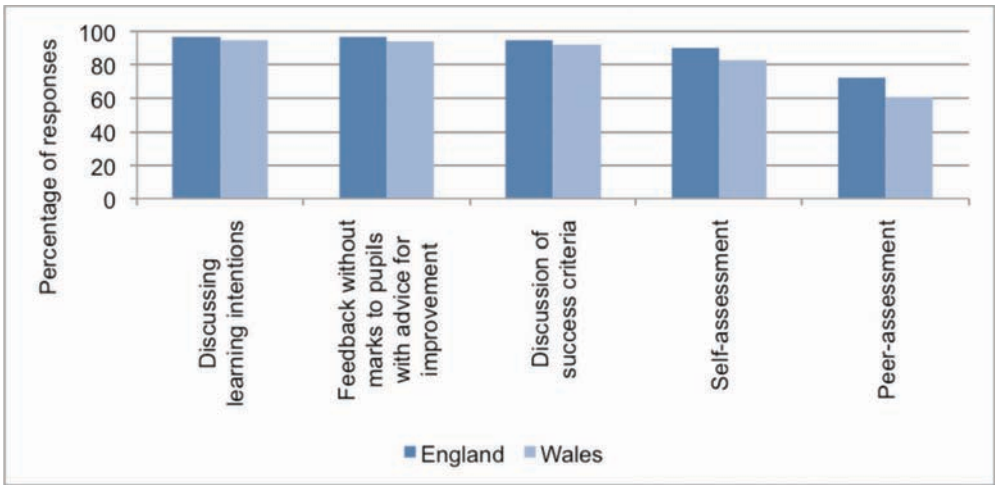

Figure 6 England and Wales: Formative assessment strategies for Y6 science

The formative assessment strategy *discussion of learning intentions with pupils* was clearly an integral part of the science teaching and learning in Y6 classes in England and Wales. This was mirrored in use by *feedback without marks to pupils with advice for improvement*, though whether this feedback related to results on practice test papers or more practical activities in science cannot be determined from these data. A similar point might be made about *discussion of success criteria* – without insight into the context of the discussion it is not possible to judge whether the success criteria referred to were related to national tests, optional tests or activities to support teacher assessment of pupils' knowledge, understanding and skills in science.

The use of pupil *self-assessment* strategies was considered important in supporting pupils' learning in science by 90% of respondents, while 72% supported *peer assessment* strategies.

3.3.1 Conclusions and recommendations

Summative assessment strategies used by Y6 teachers in England were said by participants to be selected to provide pupils with the support and feedback needed to prepare them for KS2 national science tests.

Formative assessment strategies used by Y6 teachers in England and Wales were said to focus on pupils' understanding of the learning intentions for science topics. Feedback to pupils without marks was utilised in one of two ways:

1. To inform pupils of their progress on practice tests and to feedforward in offering advice on ways in which performance in tests might be improved, or
2. To support pupils' learning in science and facilitate the use of teacher assessment for summative purposes.

Recommendation

England and Wales: There is a need for further research to explore formative teaching strategies for science used by Y6 teachers in England and Wales. The aim of the research should be to ascertain the purpose of formative strategies used and the ways in which they support the development of pupils' knowledge and understanding of science at KS2.

3.4 Assessment procedures and practices for science in Y6 in England and Wales

> *Children are being drilled in the art of answering questions, they are retaining loads of information in their short-term memory, but they're not really understanding it.* (Y6 teacher – England)
>
> *You might think a child is good at science when you are assessing them continually, but give them a test paper to see what they have learned and they are just as likely to get poor marks ...* (Y6 teacher – Wales)

This section of the report presents findings from focus group discussions that were designed to elicit views and experiences of preparation for national science tests in England and the use of optional test materials for science in Wales.

3.4.1 England: Test preparation for science in Y6 classes

Focus group questions were designed to determine whether Y6 teachers prepared pupils for national tests in science at KS2 and if so the nature and extent to which test preparation informed the teaching of science in Y6.

Participants in all focus groups in England reported that considerable time was devoted to science test preparation in Y6, particularly during the spring term. This confirmed findings from other research suggesting that test preparation was utilised by teachers in response to the high-stakes nature of national testing at KS2, where the publication of SCAATs showing percentages of pupils attaining government target levels in core curriculum areas informed teaching in English, mathematics and science throughout Y6 (Black, 1995; Brown *et al.,* 1996; Ellis, 1997; Sturman, 2003).

It was reported that test preparation typically began at the start of the spring term, though a small number of Y6 teachers claimed to maintain a normal timetable – one that included nine areas of the curriculum – until midway through the spring term when they followed the common pattern of timetable reduction. As one Y6 teacher explained:

> In the spring term it's as if only English, maths, science and PE exist, there's no more history and geography and certainly no more art or anything remotely creative like that. (EY6/SC1g)

The inevitable consequence of a reduction in the scope of the curriculum in Y6 was reported to be an increase in time available for science in the spring term. However, teachers from all schools represented maintained that this extended time was used solely for revision and test preparation. The effect of this was not simply a reduction in the primary curriculum in Y6, but a narrowing of the science curriculum itself with a focus on those aspects of science testable in paper and pencil tests, effectively eliminating all aspects of investigative science and practical activities, considered to be the heart of teaching and learning in science at KS2 (Duggan & Gott, 1995; Clarke, 2005; Harlen, 2005).

Test preparation techniques varied though all reflected the nature of national tests with a focus on reading, understanding and correctly answering questions that tested factual knowledge of science.

3.4.1.1 Published revision schemes for science

Commercially published schemes of work for science were commonly used for revision and test preparation in Y6 in the majority of schools represented. Participants identified the advantages of published schemes for test preparation as:

- Topic-based materials reflected National Curriculum for science programmes of study
- The inclusion of summative tasks and tests at the end of each topic supported teachers' assessment of pupils' progress
- The provision of lists of relevant scientific vocabulary to support teachers and pupils

- Pupil-friendly materials offered opportunities for collaborative group activities as well as independent work in science.

While participants were generally positive about the use of published schemes to support test preparation, a small number of teachers in one group objected to their use on the following grounds:

- Factual inaccuracies were found in some texts and in answers to test questions
- Some published schemes left too little to the discretion of pupils in deciding how to solve problems.

3.4.1.2 Past test papers and practice papers

Past test papers for science were used to support pupils who were ostensibly taking statutory national science tests for the first time, though in reality it was reported that past test papers were administered in the form of end of year tests in the majority of schools in Y5 and in a minority of schools in both Y4 and Y5.

All Y6 teachers used past test papers, supported by headteachers and sourced by science coordinators. They were used throughout the spring term in the following ways:

- Provide pupils with experience in completing timed science tests
- Teach science examination techniques including:
    - Reading questions for understanding
    - Answering questions asked
    - Answering questions in full taking account of number of boxes to be ticked in multiple choice questions
    - Using correct scientific terminology in write-ups and explanations.

Although all participants used or recommended practice test papers in Y6, it was thought that the process contributed little to pupils' knowledge and understanding of science in Y6. On the contrary, as one participant suggested:

> Children are being drilled in the art of answering questions, they are retaining loads of information in their short-term memory, but they're not really understanding it. (EY6/SC1i)

However, participants voiced few objections about the use of past test papers and practice papers, considering them a useful tool in helping pupils achieve the highest marks possible in statutory science tests.

There was, however, considerable criticism of statutory national science tests themselves, particularly among headteachers. They disagreed strongly with the rigid criteria for marking science tests that recognised as correct only those answers that met the criteria regardless of pupils' obvious understanding of concepts. As one headteacher stated:

> We are expecting the children to use some quite complex vocabulary. They could probably explain in their own words what is happening, but the requirement is for them

> to use the correct vocabulary and for some of our children particularly we are expecting them to use complex English before they have even learned to read and write standard English. It is possible for a child to give a really well thought out and reasonable answer to a question, but if the key word is not there no marks will be given – even if the answer is right and they show they understand. (EH5)

3.4.1.3 Effects of test preparation in Y6 on pupils and parents

Participants in all groups expressed concern about the effects of test preparation on pupils, particularly the considerable pressure on them to do well in national tests at KS2 for themselves, their parents and the school. Y6 teachers and science coordinators reported that parents worried about the wellbeing of their child throughout Y6 but at the same time displayed anxiety about possible repercussions of poor test scores when their child moved to secondary school. Participants in one group suggested that secondary schools put pressure on pupils and parents to disclose pupils' predicted levels of attainment in core curriculum subjects at open days. Some parents were said to be under the mistaken impression that their child's place at their chosen secondary school was dependent upon national test scores.

Although the majority of participants shared the view that pressure on pupils had wholly negative consequences, a small number of Y6 teachers and science coordinators claimed that some pupils found the process of test preparation stimulating, as one explained:

> Yes I agree some children find the testing regime very difficult to cope with, but other children are really motivated by it. Their behaviour improves and they become really focused on what they can achieve and they work really hard. (EY6/SC2i)

3.4.1.4 Advantages of national testing in science at KS2

Focus group participants were asked to consider the possible advantages of national testing in science at KS2. Although initial responses were wholly negative, more considered opinion suggested that national science tests confirmed the importance of science in the primary curriculum for teachers, pupils and parents. There was some support in one group for the suggestion that the quality of science teaching at KS2 had improved since the implementation of the National Curriculum and national testing in science:

> … whereas before when topics were in vogue you had to link it with other subjects all the time and you were never really sure where the science bit was going or what the children were supposed to be learning so I think the SATs have made us focus more on the learning. (EY6/SC2i)

This statement might easily be taken as a reference to the National Curriculum for science itself rather than the effects of national testing on the teaching of science, but the teacher in question insisted that if national testing for science was abolished teachers would not follow the National Curriculum for science and she gained some support for the following suggestion:

> It stands to reason, SATs concentrate the mind, teachers have to teach it, but a lot probably wouldn't cover what we cover now if they didn't have to do it for SATs. (EY6/SC2i)

3.4.2 Wales: Optional test materials for science to support summative teacher assessment in Y6

This element of focus group discussions with Y6 teachers/science coordinators, headteachers and secondary teachers in Wales sought views about the value or otherwise of optional tests for science at KS2.

All participants used optional test materials for summative assessment purposes in science, either to *inform* teachers' summative judgements of pupils' level of attainment in science at KS2, or to *support* teachers in making summative judgements about pupils' level of attainment in science. Optional test materials differed from national test papers for science, used prior to their abolition in 2004, in that teachers selected from a bank of test materials specifically designed for use in Y6, spanning National Curriculum levels 2 to 5. Optional test materials were designed to assess pupils' knowledge and understanding in each programme of study (PoS) of the science National Curriculum. Levels attained by individual pupils for each PoS were aggregated using a given weighting formula to provide a single overall level of attainment for each pupil in science at KS2.

Participants in both groups favoured the use of some form of optional test materials to inform teacher assessment and/or to provide evidence of individual progress in science in Y6. On the one hand, reservations were expressed about the assumption that teacher assessment invariably provided accurate information about pupils' knowledge and understanding in science, for instance:

> You might think a child is good at science when you are assessing them continually, but then give them a test paper to see what they have learned and they are just as likely to get poor marks in a proper test. (WY6/SC2i)

On the other hand, optional tests were thought necessary in confirming teachers' summative judgements, providing additional evidence of pupils' knowledge and understanding in science. One teacher maintained that:

> I would challenge anyone to say they could accurately assess a child's understanding through a couple of lessons on a topic when you have 30 children in the class all working away. Tests mean you can formalise it a bit more, gather evidence that they are saying this and saying that, but then answering the questions correctly as well, then you have hard evidence that they understand. (WY6/SC2j)

A small number of participants reported that the use of optional test materials had been formalised in some primary-secondary school '*clusters'*. Two teachers explained that receiving secondary schools in their clusters required all feeder primary schools to administer the same optional tests for English, mathematics and science in the summer term of Y6 to ensure consistency in KS2 assessments. However, this was not the norm among schools represented; the majority used optional test materials selected by the headteacher and/or science coordinator as an adjunct to summative teacher assessment moderated internally by Y6 teachers and science coordinators.

3.4.3 Conclusions and recommendations

Participants in focus groups in England maintained that statutory national testing at KS2 informed assessment procedures in the following ways:

- Y6 teachers were left with little option but to devote a considerable amount of time in science sessions to test preparation, particularly in the spring term
- There was a tendency for Y6 teachers to focus on aspects of science likely to be tested and this resulted in a narrow curriculum for science and fewer opportunities for pupils to undertake science investigations or other practical activities in science in Y6
- Test preparation in its current form contributed little to pupils' understanding in science. The sole purpose was to equip pupils with the necessary factual knowledge and scientific terminology to answer written questions on science test papers.

Optional test materials were used in all Y6 classes of Welsh schools represented in this research. However, practice varied in the following ways:

- In a small number of schools optional tests had simply replaced statutory national tests in Y6 as a means of determining pupils' levels of attainment in science at KS2
- In other schools optional tests were utilised to inform Y6 teachers' summative judgements of pupils' level of attainment in science
- The remainder of schools used optional test materials to provide supplementary evidence to support summative teacher assessment.

Recommendations

England: Policy makers should evaluate national tests for science. There is a need for consideration of the following:

- The extent to which preparation for science tests in Y6 classes has the effect of narrowing the science curriculum and limiting opportunities for pupils to engage in practical science work in Y6
- Ways in which science tests might be developed to ensure that tests access the full range of skills and knowledge that pupils experience in KS2 science.

Wales: There is a need for further research and monitoring of developments in the use of optional test materials for science in Y6 to explore ways in which materials are used to inform or support summative teacher assessment in providing accurate information about pupils' levels of attainment in science at the end of KS2.

3.5 Perceived and actual effects of the abolition of national testing in science at KS2

> *I would love it if we had no more tests … we could go round and question the children and gauge their level of understanding for ourselves and not be so prescriptive about what they are doing all the time. We'd be able to look at the child as a whole …* (Y6 teacher – England)

Findings from the telephone survey and focus group discussions presented in this section provide insight into the judgements of teachers in England of the

possible effects on the teaching of science in Y6 if national testing for science at KS2 were abolished. In Wales, findings focus on experiences and views of changes in the teaching of science in Y6 as a result of the abolition of national testing at KS2.

3.5.1 England: Perceptions of the effects on the teaching of science in Y6 if summative teacher assessment replaced national testing at KS2

In an open-response question, survey respondents in England were asked to identify ways in which the teaching of science in Y6 might change in their school if national testing were abolished in favour of teacher assessment. Focus group discussions were used to explore further issues affecting the teaching of science as a direct result of compulsory national testing at KS2 and ways these might be addressed if compulsory national tests for science were superseded by summative teacher assessment.

3.5.1.1 Telephone survey and focus group findings

The majority of survey and focus group responses fell within the cognitive and affective domains. Within the cognitive domain perceived advantages of the use of teacher assessment in place of national testing for science among survey respondents included:

- Reduction in focus on knowledge-based aspects of science in Y6 (36%)
- Increased time for the teaching of science generally (27%)
- Reduced focus on test preparation (24%)
- Less focus on revision of the science curriculum (22%)
- Enhanced opportunities for investigations and practical activities in science (17%)
- Enhanced opportunities for cross-curricular links (17%).

In the affective domain the potential advantages were judged by survey respondents to be:

- More interesting/enjoyable science sessions for pupils and teachers (22%)
- Less pressure on pupils to obtain the highest possible scores in tests (17%)
- Increased freedom for teachers to decide on strategies and approaches to the teaching and learning of science (14%).

There was some variation in priorities identified by sub-groups of survey respondents in the event of the abolition of national testing in science. Priorities for headteachers included:

- Less focus on testing (34%)
- Enhanced opportunities for cross-curricular links (24%)
- More investigative science in Y6 (23%).

Priorities identified by respondents in the science coordinator sub-group were:

- A less knowledge-based and more practical approach to science teaching (39%)
- Less focus on preparation for national tests (28%)

- Reductions in time spent on revision generally for national tests in Y6 (27%)
- More time for teaching and learning science (26%)
- Less pressure on teachers and pupils to prepare for national tests (20%)
- An increase in opportunities for investigative science in Y6 (14%).

Priorities for respondents in the Y6 teacher sub-group included:

- A reduction in knowledge-based approaches to science teaching deemed necessary for test preparation (51%)
- Opportunities for enhanced teaching and learning in science (26%)
- Opportunities for more investigative work in science (22%)
- Science in Y6 would be a more enjoyable experience for pupils and teachers (18%).

Survey respondents maintained that the current emphasis on knowledge transfer in science in Y6 would be replaced by investigations and practical science activities with a concentration on the development of science process skills as a means to learning in science, together amounting to over half the responses to this question (53%). In this they demonstrated an awareness and understanding of current thinking about the ways in which pupils learn in science (Driver, 1988; Harlen 2000; Sturman, 2003; Boyle & Bragg, 2005). One Y6 teacher captured the views of many others in envisaging the following change in science teaching in England:

> We would do far more practical work and we'd spend far less time teaching them how to answer the questions, i.e. the right vocabulary in answering a question. Science would become more creative and there would be more investigations. (TSE6)

This view was supported in focus group discussions where Y6 teachers and science coordinators agreed that the teaching of science in Y6 would focus on the development of pupils' skills in planning investigations, making predications, carrying out fair tests and interpreting data during science sessions.

Taken together, telephone survey responses highlighting benefits of a *removal of focus on test preparation* and *less focus on revision of the science curriculum* totalled 48% of responses. Such a change would be particularly beneficial for those pupils who were disadvantaged under the present assessment system at KS2. As one respondent put it:

> We could take more time and a slower pace so SEN and EAL children can learn more; we would teach according to what the children need rather than teaching for SATs. We could relate learning more to everyday lives. (TSE7)

Enhanced opportunities to establish cross-curricular links to support the teaching and learning of science in Y6 was identified by telephone survey respondents. As one Y6 teacher explained:

> I think I would probably cover aspects of science fitted into other topic areas rather than teaching to SATs. More linked to cross-curricular work; do it in blocks within topics that would bring in other parts of the curriculum. (TSE8)

Focus group discussions centred on the view that a move towards summative teacher assessment in science at KS2 would enable teachers to provide more accurate information about pupils' knowledge, understanding and skills in science at the end of KS2. One Y6 teacher summed up the views of the majority in saying:

> I would love it if we had no more tests. No teaching to the test all the time, we could go round and question the children and gauge their level of understanding for ourselves and not be so prescriptive about what they are doing all the time. We'd be able to look at the child as a whole, gather information over a longer period of time. (EY6/SC1j)

There was considerable support for this view across focus groups. Headteachers thought pupils would become more independent in their learning, in contrast to the current situation: dominated by test preparation, where pupils relied on teachers for all their learning in science. Y6 teachers and science coordinators commented that they would welcome opportunities to focus on the development of pupils' skills of questioning, discussion and exploration of ideas without the need for restrictions informed by the requirements of national science tests.

In the affective domain, respondents to the telephone survey envisaged experiences in science that would be more enjoyable for teachers and pupils, helping to maintain positive attitudes towards science among pupils in Y6. As one teacher put it:

> We'd have some fun. I really think that all this cramming for SATs switches children off science, they go into secondary not enjoying science. (TSE10)

Support for change in assessment procedures was not unequivocal though. A small proportion of respondents to the telephone survey (17%) thought the abolition of compulsory testing for science at KS2 would lead to little or no change in the teaching and learning of science in Y6. Reasons for this view varied – one respondent referred to current assessment procedures in KS1 in commenting:

> If teacher assessments still have to be supported by children sitting SATs papers as is done in KS1 then very little. If SATs are taken away completely then greatly, but a lot of science teaching is children learning a glossary of words. (TSE11)

A small number of participants across focus groups thought there were implications for teachers' workload if summative teacher assessment were the sole means of assessment for science at the end of KS2. Other participants – particularly headteachers and Y6 teachers – reiterated concerns expressed throughout focus group discussions about adequate classroom support to facilitate summative teacher assessment, informed by targeted assessment activities involving small groups or individual pupils. A series of targeted assessment tasks was considered vital in informing teachers' judgements about pupils' level of attainment in science at KS2. One teacher made the point that:

> There would need to be some structure in place to help you say how much knowledge and understanding a child has in science and what level they have reached by the end of Y6. (EY6/SC2k)

There was general agreement with this view; participants perceived a need for mandatory standardised assessment activities to be implemented across all schools in England. Headteachers were particularly concerned that schools should not rely solely on teacher assessment in making summative judgements about pupils' attainment in science at the end of KS2. The following comment captures the views of the majority of headteachers in the group:

> We would need clearer assessment criteria alongside level descriptors to inform proper teacher assessment without SATs because otherwise it's all the gut feeling of the individual and I'd take some convincing that that is always reliable. (EH6)

Respondents to the telephone survey were concerned that national tests should not 'simply be removed' without ensuring that 'tried and tested' moderation procedures were in place. Two headteachers thought that summative teacher assessment would only be effective in changing science teaching in Y6 if SCAATs were abolished alongside national testing. As one teacher put it:

> This depends on whether league tables are also abolished. With league tables still in place there would be no change and we would still struggle to be more practical with science in Y6. (TSE12)

There was some scepticism in both Y6 teachers/science coordinators focus groups about moderation procedures that might be introduced to support summative teacher assessment. On the one hand, participants were concerned that internally moderated teacher assessment would lead to an increase in teachers' and science coordinators' workloads. On the other hand, they anticipated external moderation procedures, involving groups of primary schools, to be fraught with difficulty due to differences in interpretation of levels of attainment in science across schools. One teacher believed firmly that:

> No one would ever agree about levels – level 3 in science in Y3 is not the same as level 3 in Y6 – people would never agree. (EY6/SC1k)

There were, however, many positive comments about the potential of moderated teacher assessment to provide insight into individual learning, considered impossible within the current system of national testing. Despite broad support, a small number were anxious about ways in which such change might be implemented, for instance:

> Would it just be brought in as another directive? Would we be expected to take it all on board without any support the way most new developments are brought in? (EY6/SC2l)

Participants called for wide consultation if the prospect of the abolition of national science tests were to be *'more than hypothetical'.* They were emphatic in their calls to *'give teachers a voice'* in any future consultation process and to '*bring in changes all at the same time'* in contrast to the

somewhat piecemeal approach to change associated with previous revisions to curriculum and assessment procedures that teachers found difficult to assimilate into existing practice.

The views of secondary science teachers in England were sought in one focus group where they were asked to consider the potential for summative teacher assessment in science at KS2 to inform teaching and learning in science at KS3 and whether such assessments should be supported by optional tests for science if national testing were abolished in favour of teacher assessment at KS2.

Initial responses questioned the value of existing assessments for science at KS2 in supporting progression in pupils' learning in science during KS2-KS3 transition. A small number of participants claimed never to have consulted pupils' records in science sent from primary schools, preferring to administer their own tests during the autumn term of Y7, and this was common practice across the group. The reason for this was a 'lack of consistency' in teaching and learning science across feeder primary schools. As one participant explained:

> Whatever we get from primary schools should be standardised in some way so that the pupils come through with something that science teachers can depend on and to work with in developing their schemes of work for science and that's not the case now. (ESSTa)[5]

This view is consistent with research studies that have identified high levels of mistrust among secondary teachers of assessed levels of attainment in science in national tests at KS2, principally because secondary teachers believed that pupils' levels were artificially inflated as a result of intensive revision and test preparation (Ellis, 1997; Bunyan, 1998; Collins, 1999; Schagen & Kerr, 1999).

Participants maintained that the source of information about pupils' level of attainment in science at KS2 was largely irrelevant provided assessments were 'honest and accurate'. The group agreed that the accuracy of summative assessment in Y6 would be improved through the introduction of sub-levels of attainment at KS2. As one teacher explained:

> … the information is in the sub-levels – a level 5 on a science test is not useful to us at all because level 5 is so broad, we need sub-levels so we can see if a student has just scraped in above level 4, or is closer to a level 6. (ESSTb)

Participants maintained that if summative teacher assessment at KS2 was to be accurate and meaningful it would need to be informed by clear criteria, coupled with 'rigorous' and 'consistent' moderation procedures and processes involving panels of secondary science teachers and Y6 teachers from feeder primary schools, together with members of the local authority science advisory team. If requirements were met, summative teacher assessment had

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[5] ESST denotes England Secondary Science Teachers; lower case letters denote individual responses.

the potential to provide more reliable information for secondary science teachers about pupils' attainment in science at KS2 than was the currently the case.

3.5.2 Wales: Changes in Y6 science teaching as a result of the abolition of statutory testing in 2004

> *There has been a huge move in science education away from content onto skills. The children's attention is being drawn to Sc1 all the time, more 'What skills are you using here?' than 'Can you tell me what's a conductor, what's an insulator?'* (Y6 teacher – Wales)

Questions put to telephone survey respondents and focus group participants in Wales aimed to explore the impact of actual changes in assessment procedures and practices for science at KS2 on teachers and the teaching of science in Wales.

Telephone survey responses to this question were recorded verbatim to gain insight into the effects, if any, of the abolition of KS2 statutory testing on the teaching of science in Y6. Focus group questions were designed to elicit individual experiences and views of the impact of changes in assessment procedures since 2004 on the teaching and learning of science in Y6.

The majority of responses to telephone survey questions again fell into the cognitive and affective domains while a small number expressed a reluctance to embrace change. Categories of responses to the telephone survey question included:

- Reduction in pressures of test preparation (23%)
- Easing of pressure generally for teachers in the teaching of science in Y6 (18%)
- Enhanced opportunities for teaching and learning of science in Y6 (18%)
- Greater emphasis on the development of pupils' science process skills to support learning in science (16%)
- Increased opportunities for science investigations (15%)
- Greater freedom and flexibility for teachers in deciding on content and strategies for science teaching (15%)
- Increased opportunities for practical science activities (14%)
- More interesting and enjoyable science lessons (13%)
- Increased focus on teacher assessment (11%).

However, not all respondents welcomed changes in assessment procedures and practices.

Focus group participants raised some similar points, though issues discussed differed in other important respects. The principal areas of change in the teaching of science were:

- There is now greater emphasis on the development of pupils' science process skills as a means of understanding in science, informed by

National Curriculum *Scientific Enquiry* (Sc1) component of the programmes of study.

- Revised assessment procedures had led to changes in teaching strategies and approaches to science in Y6, for example:
    - Group work has largely replaced whole class teaching in science to facilitate teacher assessment
    - Teachers are more involved in observation, discussion and questioning of individual pupils to support teacher assessment.

Other areas of discussion related to assessment procedures; the principal areas of discussion focused on the following:

- As there is no set time frame for schools to adopt revised systems of assessment in Wales. Schools are, therefore, currently operating at a point along a continuum ranging from no change in summative assessment procedures to full use of summative teacher assessment, supported by optional test materials in English, mathematics and science.
- Issues of continuing professional development need to be addressed if summative teacher assessment in science is to be effective.
- Progress in the implementation or further development of summative teacher assessment procedures and practices in science was hampered by the following:
    - A lack of consistency in guidance and directives from policy makers
    - A lack of information concerning the content of the revised curriculum for science in Wales, to be implemented in autumn 2008.
- Secondary science teachers have been unable to form judgements about the extent to which revised assessment procedures and practices at KS2 might impact on science teaching and learning at KS3 and on pupils' learning in science during KS2-3 transition in the future.

Whether participants in focus groups were discussing changes in the teaching of science since the abolition of national testing in principle or in practice – depending on the extent to which their schools had embraced change – there was consensus across groups of Y6 teachers/science coordinators, headteachers and secondary science teachers that the abolition of national testing and associated publication of SCAATs had been a positive and welcome change in primary and secondary education generally in Wales.

Among focus group participants, a total of seven Y6 teachers and science coordinators and three headteachers represented schools where optional test materials continued to be used for summative purposes in preference to moderated summative teacher assessment at KS2 – one school had retained external marking of optional tests paid for from the school's budget. In these schools little had changed in the teaching of science in Y6 since 2004; teachers continued to revise the entire KS2 science curriculum in Y6 and test preparation practices mirrored those described by teachers in England.

The following responses from Y6 teachers to the telephone survey question captured in essence the views of over 20% of respondents in describing Y6 science lessons no longer dominated by the need for revision and test preparation:

> We teach science up until the end of Y6 rather than revising for SATs. Children and staff are happier and more successful. More problem-solving as opposed to regurgitating facts. (TSW3)

> I would say a positive effect is that we used to teach for the tests and now we can teach a broader range of scientific subjects. (TSW4)

The majority of respondents mentioned an easing of pressure on Y6 teachers to prepare pupils for national science tests, which in turn made it possible for teachers to extend pupils' learning in science in Y6 in ways that were impossible before the abolition of testing at KS2. The view of one respondent captures well the sense of relief felt by many:

> We can breathe again, there's more time to go over something they really haven't understood, we do a bit less now but we do it better. There's not so much pressure now, we can relate it more to the outside world. (TSW5)

During focus group discussions Y6 teachers and science coordinators highlighted a need for a change of emphasis in Y6 science lessons towards *Scientific Enquiry* (Sc1) to support summative teacher assessment. Pupils were now required to demonstrate their knowledge and understanding of science at a particular level through investigations and practical application of concepts rather than simply answering test questions at that level. The CELIPS scheme of work, weighted towards the use of scientific process skills in developing pupils' knowledge and understanding, informed much science teaching in Y6. One teacher summed up a more widely held view in stating:

> There has been a huge move in science education away from content onto skills. The children's attention is being drawn to Sc1 all the time, more 'What skills are you using here?' than 'Can you tell me what's a conductor, what's an insulator?' (WY6/SC1h)

The most positive views across sub-groups of telephone survey respondents were expressed by headteachers who fully supported a change in emphasis from content towards the *Scientific Enquiry* component of the programme of study at KS2. They welcomed the enhanced freedom and flexibility offered to schools in structuring the teaching and learning of science throughout KS1 and KS2 to take account of the needs of all pupils.

Science coordinators formed the highest percentage of respondents who supported the abolition of statutory testing for science at KS2. They were positive about increased opportunities for practical science activities and investigations in Y6 since the abolition of statutory national testing for science.

Y6 teachers welcomed a shift in emphasis away from the need for test preparation towards a focus on summative teacher assessment at KS2. Changes had resulted in an easing of pressure to revise the KS2 science curriculum in two terms and prepare pupils for tests – all of which resulted in more interesting and enjoyable science sessions for pupils and for teachers.

Focus groups of Y6 teachers and science coordinators reported that it had been necessary for Y6 teachers to make adjustments to teaching strategies for science to facilitate summative teacher assessment. Enhanced use of strategies such as observation of pupils during science sessions combined with questioning and discussion with individuals and small groups to determine levels of understanding had become crucial in informing teachers' judgements of pupils' attainment in science. To facilitate this, teachers now found it necessary to set clear criteria for assessment at the planning stages of each science topic in Y6 to inform summative teacher assessment. One teacher explained:

> We are expected to decide not just the learning objectives for the topic, but the criteria for assessment as well. Then you can say, 'I know he understands this concept and that concept and he's achieved this level in this area of science', and this is the criteria I used. (WY6/SC2h)

Focus group participants described teaching strategies for science that embraced practical activities and investigations involving small groups of pupils in preference to whole class teaching. Pupils typically used concept mapping to record initial ideas and they devised tables to record predictions and results of investigations. This was in direct contrast to science teaching prior to 2004, which was recalled as being driven by a need to prepare pupils for national science tests. The following exchange reflects the views of participants in one focus group:

> Often before the science was lost really because it became just a handwriting lesson when they wrote up their experiments. They'd write, 'We asked this question and this is what we thought and this is what we did and this is what we found out'. And that's fine if that's what you're focusing on, but you had to make sure they were writing the right answers … (WY6/SC1i)
>
> Yes, and often it wasn't really their work at all – they might not have got as far as they should have with their experiment but they still had to get it down in their books. (WY6/SC1j)

This was not to suggest that participants thought recording in science unimportant but they emphasised the need for purpose in pupils' recording, insisting that copying from the board merely to ensure that every pupil had correct factual information in his/her science book devalued the process of science and became little more than a *'pointless writing-up exercise'*.

Although the majority of respondents to the telephone survey resoundingly endorsed changes in assessment procedures for science at KS2, a small number experienced little actual change in practice. As one respondent commented:

> Very little [has changed][6] really, the least of all the subjects; they are still assessed on what they know, we still work towards achieving a level and are under pressure to get everyone up to that level. (TSW6)

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[6] Brackets inserted.

Others expressed reservations about the use of teacher assessment in forming judgements about pupils' level of attainment in science at KS2. As two Y6 teachers explained:

> It's harder to level, it has increased the need for creating data from an early age because there are no standardised tests now so it makes it harder. (TSW7)

> The teacher assessments are being questioned. We were secure in having the SATs even when we didn't like them and we are now looking to the moderation of judgement with cluster schools and how to secure that. (TSW8)

During focus group discussions headteachers, though supportive of changes in assessment procedures, particularly the easing of pressure on teachers and pupils to prepare for national tests, were circumspect in their support for the prominence of Sc1 in the teaching and learning and assessment of science in Y6. They formed the view that it might take some time to realise changes in practice as some Y6 teachers were unfamiliar with alternative teaching strategies for science and needed encouragement to utilise practical activities and investigatory science as the foundation of teaching and learning. However, headteachers were reluctant to impel teachers to seek professional development in this area until they had a clear view of the content of the new curriculum for science to be introduced in September 2008. One headteacher summed up the more general view of the group in explaining:

> We are in a state of flux here with the new curriculum coming in 2008. The draft documentation we've had has Sc1 and that's it; there's a strong focus on skills and no sense of the knowledge and understanding part at all. It makes it difficult for headteachers to know quite where to start introducing things into our schools, there's just not enough information filtering through from DELLS to actually know how to proceed effectively for September 2008. (WH6)

Headteachers thought the CELIPS scheme of work was intended to 'pave the way' for the new science curriculum, but this was a Cardiff-based initiative and they called for the DELLS and the Welsh Assembly to provide clear and consistent guidance on assessment requirements in core curriculum subjects at KS2 for the whole of Wales.

Secondary science teachers in Wales discussed the extent to which the abolition of national tests for science had resulted in changes in pupils' scientific skills when they entered KS3. The general view was that it was too early to make judgements about the impact of change in assessment procedures at KS2 on pupils' science skills or on their knowledge and understanding of science. Teachers thought it would be necessary to wait until the implementation of the new curriculum for science in 2008 as current summative teacher assessment procedures and practice had been *'bolted on'* to an existing science curriculum and participants felt the current science curriculum at KS2 did not lend itself well to the development of pupils' scientific skills.

3.5.3 Views of current assessment procedures for science at KS2 in England and Wales

Respondents to the telephone survey in England and Wales were asked to rate a number of statements about current assessment procedures and practices on a scale from *strongly agree* to *strongly disagree.* The statement referring to the use of optional tests in the absence of national tests for science (Figure 7) was phrased differently for respondents in England and Wales to reflect assessment procedures in each country.

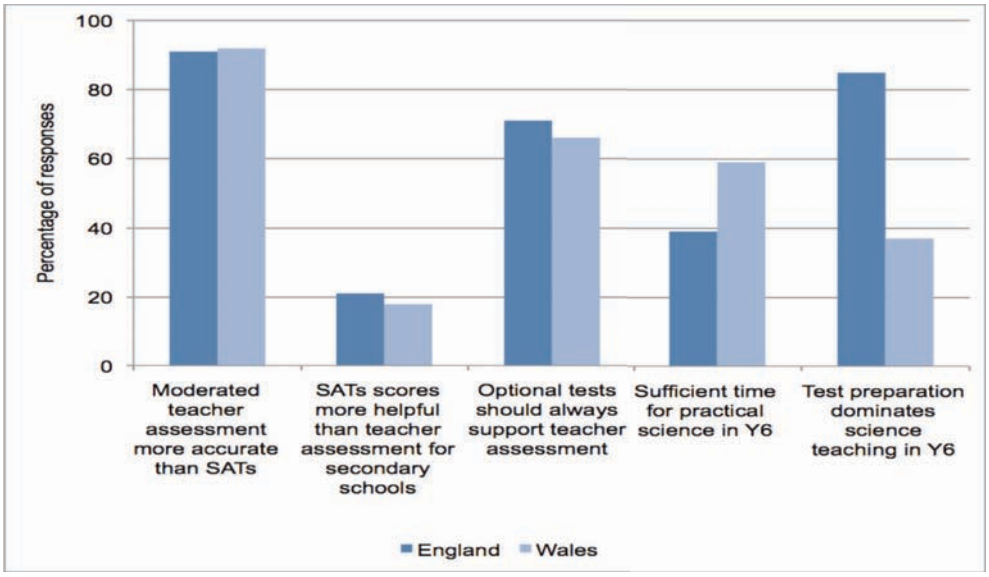

Figure 7 England and Wales: percentage of responses in agreement with statements

Respondents in England and Wales showed marked confidence in the accuracy of moderated teacher assessment over science national test scores in providing information about what pupils know, understand and can do in science at KS2. There was significant agreement across sub-group in each country:

- Headteachers: England 94% Wales 95%
- Science coordinators England 95% Wales 91%
- Y6 teachers England 84% Wales 91%.

While less than 20% of respondents thought that national test scores in science provided more accurate information for secondary science teachers about pupils' levels of attainment in science, over 60% of respondents from England and Wales supported the use of optional test materials to substantiate teacher assessment. Responses across groups in England and Wales confirmed research findings (e.g. Clarke, 1998; Black, 2001; Wiliam *et al.,* 2004) that test preparation dominated teaching in Y6, allowing little room for teachers to make decisions about curriculum content to be covered or teaching strategies to be deployed in supporting pupils' learning.

Areas of notable difference between the two countries were:

1. Judgements about the adequacy of time available for practical science in Y6. Findings confirm comments made by teachers throughout the present research that the time required for test preparation in England

limited opportunities for practical science in Y6. In Wales changes in assessment procedures made it possible for teachers to incorporate practical activities more fully into science lessons in Y6.

2. Test preparation was a feature of science teaching and learning in Y6 in England, while responses from teachers in Wales showed that test preparation did not dominate science teaching to the same degree in Y6 classes.

3.5.4 Conclusions and recommendations

Conclusions

Participants in England were generally positive about the potential advantages to teachers and pupils of an abolition of national testing in science at KS2 in favour of summative assessment of pupils' levels of attainment in science. The key benefit was perceived to be an opportunity for Y6 teachers to integrate science investigations and other practical activities more fully into science lessons throughout the year. However, teachers stressed that the success of such an initiative would largely depend on the quality of internal and external moderation procedures and practices in ensuring consistency in interpretations of levels of attainment within and across schools.

Survey respondents and focus group participants in Wales suggested that the abolition of national testing and developments in summative teacher assessment for science at KS2 had positively affected the teaching of science in Y6 classes in those primary schools where changes in assessment procedures and practices had been more fully implemented. Freed from the restrictions of test preparation teachers said they were beginning to utilise a broader range of teaching strategies, encouraged by requirements for summative teacher assessment to include judgements of pupils' levels of attainment in all KS2 National Curriculum programmes of study for science.

Headteachers in Wales, while fully supportive of changes in assessment procedures for English, mathematics and science at KS2, called on the Welsh Assembly and local authorities to provide the following:

- Clear and consistent guidance on summative assessment procedures at KS2 from DELLS and the Welsh Assembly
- Detailed information about the content of the proposed revised KS2 curriculum for science to be implemented in 2008 to inform action plans for continuing professional development for Y6 teachers.

Secondary science teachers in England claimed to mistrust national science test results. Test scores were said to provide inaccurate information about pupils' actual levels of attainment in science at the end of KS2, necessitating re-testing of pupils during the autumn term of Y7. Participants thought that summative teacher assessment had the potential to provide more accurate assessments with the caveat that this was dependent on clear assessment criteria, rigorous moderation procedures and the use of sub-levels in the assessment of pupils' attainment at KS2 to further enhance accuracy.

Survey responses provided clear evidence to support findings of other studies that test preparation in England dominates the teaching and learning of

science in Y6. Evidence emerged of a strong conviction among survey respondents in England and Wales that moderated teacher assessment was capable of providing more accurate information about pupils' levels of attainment in science at KS2 than national test scores.

Recommendations
Wales: Further research and monitoring of developments in assessment procedures and practices should be undertaken to explore:

- Developments in assessment procedures for science at KS2 to identify factors likely to encourage or inhibit the use of summative teacher assessment in science by Y6 teachers
- The revised National Curriculum for science with an emphasis on the extent to which it supports changes in summative assessment procedures and practice at KS2
- Progress in Welsh Assembly guidance to support the development of summative teacher assessment for science at KS2.

England: Research on primary-secondary transition should be undertaken to explore the following:

- Existing good practice in supporting pupils' learning in science during transition from KS2 to KS3, to identify ways in which this might be disseminated
- Factors that support pupils' learning in science and those that inhibit progression in individual learning and impact on pupils' attitudes towards science during transition between primary and secondary school.

3.6 Perceptions of links between assessment and standards

> *Parents want to know that their child progressed well at school, they try hard and are polite and get on with other pupils. They are not interested in knowing where their child is in relation to anyone else's child.* (Headteacher – England)
>
> *Parents in some schools wanted to keep the tests because they approved of testing, but they didn't understand what the results mean.* (Headteacher – Wales)

Issues concerning the importance of SCAATs (league tables) in providing information to parents and others about primary schools and the extent to which these tables should be used to form judgements about the quality of education provision at classroom and whole school level were explored in the telephone survey and in focus groups of headteachers in England and Wales. This issue was of particular importance to the present research as it provided opportunities to explore the effects of the abolition of SCAATs in Wales as a means in of informing parents and others about the quality of educational provision in primary schools.

Respondents to the telephone survey in England and Wales rated on a five-point scale the extent to which they agreed/disagreed with a number of statements about the links between assessments and standards in science.

This aspect of the telephone survey included one statement specifically related to issues of assessment and standards in each country. Respondents were asked to rate the following statements:

A. England: *Scores from national science tests at KS2 accurately reflect the performance of individual schools in science*.
   Over half of all respondents **disagreed** with this statement (60%), though there was some variation between sub-groups:
   - Headteachers – 70%
   - Science coordinators – 58%
   - Y6 teachers – 52%.

B. Wales: *The abolition of national testing for science has improved standards of attainment in science in Y6*.
   More than half of respondents (55%) **agreed** with this statement, demonstrating a confidence in the actual or potential impact of the abolition of science tests on standards of attainment in science at KS2. There was some variation between sub-groups:
   - Headteachers – 62%
   - Science coordinators – 55%
   - Y6 teachers – 48%.

There was no significant difference in responses across the two countries to the following statements:

A. *SCAATs should not be used to judge individual schools and teachers.*
   Agreement with the statement:
   - England – 85%
   - Wales – 87%

B. *SCAATs provide vital information for parents and others about teaching and learning in science in individual schools.*
   Disagreement with statement:
   - England – 68%
   - Wales – 54%

Consensus was reached among headteachers in England concerning the perceived inadequacy of national test scores in forming the basis of communication with parents about the progress and level of attainment of their child in science at KS2.

Headteachers maintained that the majority of parents did not understand the meaning of *levels of attainment*, rendering them *'useless in any form of communication'*. Headteachers reported difficulties in explaining to parents why their child did not move through National Curriculum levels consistently, one level each year and why their child's progress in science appeared static perhaps over a two year period when there was no change in the recorded level of attainment in science for their child. One headteacher gained some support for his claim that:

> Parents want to know that their child has progressed well at school, they try hard and are polite and get on with other pupils. They are not interested in knowing where their child is in relation to anyone else's child. (EH8)

This was not the case in every school, however, as other headteachers gave examples of parents demanding to know why their child had not achieved the same level in a particular core subject as his/her friend, or a brother or sister in previous years. One headteacher thought parents were:

> … exceptionally tuned in and well aware of the meaning of a level 3 in science as a opposed to a level 5 for science in Y6. (EH9)

Headteachers reported that all parents received end of Key Stage reports detailing their child's progress in all curriculum areas with levels of attainment in English, mathematics and science. All headteachers agreed, some reluctantly, that even if national testing were to be abolished in favour of summative teacher assessment they would support the continued use of levels of attainment for every pupil at KS2.

Headteachers in Wales reported some difficulty in convincing parents that the abolition of national testing in English, mathematics and science had positive implications for their child's education, for example:

> Parents in some schools wanted to keep tests because they approved of testing, but they didn't understand what the results meant. (WH7)

Agreement across the group led to a great deal of anecdotal evidence of parents' failure to understand test results. These included parents who thought level 1 for science was a great achievement as it must be the highest possible level of attainment. The majority of parents in another school were said by one headteacher to be only too aware that level 5 for science was a very good result and he had been appalled at the incentives and promised rewards offered by parents to their children to do well in tests. Participants expressed relief that they no longer had to deal with the pressures of parents weeping because their child had failed to reach expected/desired levels of attainment at KS2.

Although levels of attainment were recorded and reported to parents at the end of KS2, headteachers reported that it was now common practice for Y6 teachers to discuss each child's progress and level of attainment with parents. In addition schools provided *'carefully worded'* reports detailing pupils' strengths and achievements and identifying attainable targets in each strand of the science curriculum for KS3. One headteacher described changes in her school as follows:

> We don't use computer-generated reports anymore, it is all personalised now so that parents are left in no doubt about their child's progress. This is very important for us because we have a lot of non-English speaking parents in Cardiff and they need to be able to understand how their child is doing and they won't do that through trying to read stock phrases taken from the computer. (WH8)

Headteachers in England agreed that SCAATs – referred to throughout the discussion as *league tables* – based on national test results should not be

used for purposes of accountability. No consensus was reached concerning the extent to which parents took account of SCAATs. A small number of participants maintained that parents were not interested in the tables and that decisions about where to send their children were not informed by SCAATs but by *'word of mouth'.* The remainder of the group were adamant that SCAATs were the single most important factor in informing parental choice of school for their children – one cited as evidence the details of local estate agents who boasted about houses within the catchment area of good primary schools. However, they were in agreement about the importance of SCAATs for other purposes. As one headteacher explained:

> League tables are used by other professionals, our *School Improvement Partners*, the local authority, Ofsted and so on, to judge us by and underneath it all that does matter a great deal to all of us. (EH10)

They argued for the implementation of more effective and accurate ways by which schools might be held accountable, as SCAATs based on national test scores provided inaccurate information about pupils' actual attainment in English, mathematics and science, the expertise of teachers at KS2 and an incomplete view of the educational provision offered by the school.

3.6.1 Conclusions and recommendations

Conclusions

Participants in England expressed dissatisfaction with the current practice of basing SCAATs on national test scores for science at KS2. The main reason was the perceived inaccuracy of national tests in determining pupils' levels of attainment in core curriculum subjects at KS2.

Following the abolition of SCAATs in Wales in 2004, headteachers had devised alternative strategies to inform parents of Y6 pupils about their child's progress and summative level of attainment in science at KS2. While communication currently involves a relatively lengthy process of parent-teacher discussion and personalised reports, it was said that this provided more accurate information than was previously the case when reporting to parents was based on pupils' national test results.

Recommendations

England: Policy makers should review the appropriateness of the formulation of SCAATs based on national test scores in English, mathematics and science.

Wales: Further research should be undertaken to explore the nature and effectiveness of procedures introduced to replace SCAATs to inform parents about their child's progress and attainment in science at KS2.

Appendix 1

Full review of literature

While there is considerable literature of the use of formative and summative assessment procedures and practices to monitor pupils' learning and identify levels of attainment in science through the period of compulsory education, few studies have focused specifically on the effects of compulsory national testing on teachers and the teaching of science at KS2. Therefore this present research is informed by research studies and findings that provide insight into the use of statutory national testing and teacher assessment for summative purposes in judging pupils' levels of attainment in science at KS2.

National testing: views of summative and formative assessment

While formative assessment has the sole purpose of informing teaching and learning, summative assessment in the form of national tests has multiple purposes in that outcomes might be used for a variety of 'internal' and 'external' purposes. Internal purposes include monitoring pupils' progress over time using National Curriculum levels of attainment to inform pupils and their parents. External purposes include monitoring the performance of schools and school accountability. It is argued that when external assessment becomes 'high stakes' there is a consequent effect on internal assessment as it emulates external procedures, having a direct influence on what is taught and how it is taught throughout the school. (ARG, 2001; Pollard *et al.,* 2000; Harlen, 2005).

Education in England and Wales has long been dominated by a system of statutory national testing. A number of research studies have concluded that such educational assessments are largely ineffective and even detrimental to the provision of quality education for pupils in primary and secondary schools. The dominance of an assessment system that relies on national testing is said to reflect an interpretation of the purpose of education as the certification of the achievement of individuals – summative assessment – and the use of assessments designed for this purpose to provide information about the quality of education offered by schools – evaluative assessment (Harlen *et al.*, 1992; Gipps, 1994; Black, 1995; Gipps *et al.*, 1996; Massey, 1997; Wiliam, 2001; ARG, 2002; Harlen, 2003; Broadfoot & Black, 2004; Black, 2005; Moore, 2005; Black & Wiliam, 2006; Harlen, 2007).

Statutory testing of the core subjects within the National Curriculum at Key Stages 1, 2 and 3 in England continues to employ largely paper and pencil approaches, a practice that has prompted a number of researchers to explore the validity and reliability of test outcomes (Wiliam, 1993; Gipps, 1994; Stobart, 1999; Moody, 2001; Doyle & Godfrey, 2004; Black & Wiliam, 2006; Harlen, 2007). Of particular interest for this current research is the assertion that while data from standardised tests may be found reliable in the assessment of groups of pupils – at class, cohort and school level – their reliability in providing an accurate assessment of individual pupil attainment and for monitoring progress in pupils' learning is substantially less. The

importance of validity and dependability in testing takes on considerable significance at KS2 for two reasons. First, despite the fact that teacher assessment and test results are intended to carry equal weight, a dependence on the outcome of tests at the end of KS2 for 'high stakes' purposes has resulted in higher status for tests. Second, there is an expectation that teachers in Y7 will uses test results as a baseline assessment for the measurement of pupils' progress throughout KS3 (Black, 1995, 1998; Schagen & Kerr, 1999; Wiliam, 2001; Newton, 2003).

Validity and reliability of statutory national tests

An important consideration in the assessment of pupils' attainment in science at KS2 is not only whether tests measure what they are intended to measure (face validity), but the extent to which they are capable of doing so (content validity). It is not sufficient to judge the extent to which a test appears valid to pupils, teachers and other interested parties, but whether the responses elicited by the tests attune to the requirements of valid assessment (Schagen, 1993; Shorrocks-Taylor, 1999; Wiliam, 2001). Wiliam (2001) maintains that high stakes end of Key Stage national tests, such as those at KS2, lack validity in that they assess only a small proportion of the National Curriculum in each tested subject. He argues that:

> In low-stakes contexts, the limited range of achievement that is assessed in the tests can stand as proxy for achievement across the whole subject. However, in high-stakes contexts there is pressure to increase the student's performance in those aspects of the subject that will be tested … Standards of achievement in the tested areas will rise, but only at the expense of untested areas. Therefore while the *reported* standards of achievement may rise, the actual level of achievement across the whole subject could well be falling, and the tests are no longer an adequate proxy for achievement across the whole domain. (Wiliam, 2001, p. 11)

This argument suggests that if teachers teach only those parts of the curriculum likely to be tested, then it cannot be assumed that test results represent levels of attainment, or proficiency, in broader subject domains. Therefore teaching to the test has a negative impact on the validity of any inferences taken from national test results (Wiliam, 2001; Black & Wiliam, 2006). Stobart (1999) concluded that the combination of national tests and teacher assessment in KS2 and 3 represented a valid assessment system, but the use of test results for purposes of accountability diminished the role of teacher assessment in monitoring pupils' progress in core curriculum subjects.

In assessment terms reliability refers to the consistency of information derived from assessments, for example, information might be considered reliable if a pupil's score on the same test given twice was similar. The reliability of national tests at KS2 has been questioned on the grounds of an inherent difficulty in assigning levels of attainment to individual pupils. It is argued that even with a reliability coefficient that might generally be considered acceptable – within the range 0.85 to 0.9 – the errors in pupils' scores that this implies mean that a significant proportion are awarded an incorrect level. At KS2 this might be as high as one third of pupils (Woods, 1991; Wiliam, 1993;

Nicholls & Smith, 1998; Schagen, 2006). Although Newton (2003) firmly rejected claims of 'misclassification' of test results (p. 109), no comprehensive studies have been undertaken to demonstrate reliability.

Assessment procedures and processes

It has been argued that the present system of statutory end of Key Stage testing has little to do with learning and the potential contribution of teacher assessment has been largely neglected (Gipps, 1999; ARG, 1999; Black, 2001; Black & Wiliam, 2003; Clarke, 2005; Harlen, 2005; Moore, 2005). In their review of the first ten years of the journal *Assessment in Education*, Broadfoot and Black (2004) claimed that the demands of National Curriculum assessment created tensions for teachers who were, on the one hand, encouraged to focus teaching and learning on the needs of the individual pupil, integrating AfL into classroom practice, while on the other hand, were under pressure from within and outside their school to consistently improve results of national tests. This view is supported by others who maintain that education is governed by a policy agenda that measures excellence in schools only by performance in national tests and attainment tables (Boyle *et al.,* 2004; Boyle *et al.,* 2005; Boyle & Bragg, 2005).

The Assessment Reform Group argued that negative consequences of summative assessment might be minimised by: more appropriate use of teachers' judgements, which should be underpinned by quality assurance procedures; understanding of developmental criteria; access to well designed assessment tasks; structured and focused professional development. Summative and formative assessment procedures should be harmonious and transparent, with teachers' judgements supported by evidence so that all concerned can trust the results (ARG, 2006).

Teacher assessment for summative purposes

The use of teacher assessment for summative purposes at the end of KS1, 2 and 3 is of particular importance in Wales since the abolition of national testing in 2004. No evaluations or studies of the transitional period in Wales have yet been published, though several educationalists have offered insight into the advantages and potential drawbacks of utilising teacher assessment for summative purposes (Woods, 1991; Pollard *et al*.,1994; Gipps *et al.,* 1996; Harlen, 2003, 2005; ARG, 2006).

In considering arguments in favour of summative teacher assessment the Assessment Reform Group (ARG, 2001) listed several key points, for example:

- Teachers are considered to be well placed to build an accurate picture of individual pupil attainment across the full range of teaching and learning goals and activities
- Summative teacher assessment relieves the pressure of external tests on teachers and pupils and is therefore capable of providing more valid and accurate indications of individual pupil attainment
- Released from the pressure of test preparation teachers are able to pursue learning goals in ways best suited to their pupils

- A more collaborative approach to summative assessment is possible, where pupils are actively involved in self-assessment thus deriving a sense of progress towards 'learning goals' as opposed to 'performance goals' (p. 4)
- Summative teacher assessment has the potential to fulfil the dual purpose of formative assessment to support and facilitate progress in individual learning and summative assessment to provide information about pupils' levels of attainment for internal and external purposes.

The possible disadvantages of summative teacher assessment highlighted by the ARG (2001), supported by research evidence, included a suggestion that teacher assessment was subject to unreliability and bias, though no details were offered to support this claim. A further possible drawback was a possible increase in the workload of teachers and schools, particularly as the introduction of potentially over-elaborate moderation procedures could constrain teachers in their assessments, leading to 'safe' judgements of pupils' levels of attainment. The ARG concluded that the dependability of teacher assessment for summative purposes rested on the quality of resources provided and on professional development for moderation and assessment planning.

In their study of models of teacher assessment at KS1 and KS2 Gipps *et al.* (1996) highlighted a further challenge in utilising teacher assessment for summative purposes. They found that teachers generally lacked confidence in their own end of Key Stage assessments, evidenced by the collection of large quantities of materials including mark sheets and examples of pupils' work to substantiate their judgements. This lack of confidence was a consequence of inadequate preparation or training for teacher assessment at KS2.

Testing as a means to raising standards in science education at KS2

Prior to the implementation of the National Curriculum in England and Wales, there existed considerable variation in content and a lack of consistency in approaches to teaching, learning and assessment in primary science, extending to a complete absence of science education in many primary schools (Swain, 1989). Primary teachers had little experience of managing practical science sessions in the classroom or of selecting tasks and investigations that were well matched to pupils' experience and understanding in science (Russell *et al.,* 1995; Ofsted, 1993).

Initial consultations on the nature of assessment in science, undertaken by the *Task Group for Assessment and Testing* (TGAT), involved primary and secondary teachers, academics and national inspectors. The work of the *Assessment of Performance Unit: Science Project* (APU, 1978-1990) clearly informed recommendations for primary science that called for balanced assessment of scientific process skills and content. Initial TGAT recommendations identified a wholly formative system with teacher assessment central to the process. Following consultation, revised proposals aimed to support primary teachers in the use of national tests in science as a means of moderating and calibrating teacher assessment. These proposals

were rejected and by 1993 national test results were awarded equal weighting to teacher assessment at KS2 (Black, 1995).

Research evidence suggests that in the period immediately following the implementation of the Science National Curriculum, primary teachers struggled to make sense of assessment requirements (Russell *et al.,* 1994). Many primary schools recorded details of science topic work as formative assessment; others collected huge quantities of detailed test and teacher assessment records – following guidance from local authorities – but Harlen (1991, 1996) reported that these were rarely used to good effect in informing teaching and pupils' learning in science at KS2. In contrast to this moderated teacher assessment was an established part of science teaching and learning in secondary schools where schemes for modular or graded assessment utilised moderated teacher assessment for summative purposes (DES, 1988; Black, 1995).

The impact of national testing on science at KS2

Several research studies have concluded that education dominated by summative assessment fails to promote learning and may actually inhibit the development of pupils' knowledge and understanding (ARG, 1999; Black, 2001; Black & Wiliam, 2003; Clarke, 2005; Harlen, 2005; Moore, 2005). This has important implications for science at KS2 where scientific process skills or experimental and investigative science are at the heart of teaching and pupils' learning (DFE, 1995; OECD, 1998). Scientific process skills cannot be considered as separate from scientific concepts (Squires, 1980; Duggan & Gott, 1995). Indeed, Harlen (1999) refers to scientific process skills as 'a face of a solid three-dimensional object, integral to the whole … but having no independent existence' (p. 129). This supports the views expressed by Squires (1980) who emphasised the interrelationship of scientific content and the process of scientific enquiry, at least for primary pupils. She called for an emphasis on scientific investigation as a way of encouraging the development of pupils' scientific ideas, a proposal later endorsed by Feasey (1993) who argued that scientific investigations should be used as a means of enhancing both skills of enquiry and conceptual knowledge simultaneously.

Despite these strong arguments, spanning over twenty years of primary science education, assessment of pupils' scientific process skills does not feature strongly in national tests for science at KS2. Views differ concerning why this might be the case; Harlen (1999) thought this was due in part to technical difficulties associated with the assessment of some process skills, though she insisted that these might be solved 'where there is will to do so' (p. 130). Tobin *et al.* (1990) adopted a different perspective in suggesting that assessment reflected a view of the purpose of science education as the acquisition of scientific concepts and knowledge

Test preparation for science at KS2

Boyle *et al.* (2004) identified as the main challenges faced by teachers at KS2 a perceived or real need to prepare pupils for national tests in science and linked to this a lack of time devoted to science in the timetable at KS2. Their longitudinal study of teacher development sought to explore reasons for a lack

of practical science throughout KS2. They concluded that while the extent of reduction in time allocated to the foundation curriculum at KS2 was 'alarming', alongside this was a measurable reduction in teaching time for science, which as a core curriculum subject should have had parity, or near-parity, with English and mathematics (Boyle *et al.,* 2004; Boyle & Bragg, 2005). The authors maintained that this was perhaps an inevitable consequence of pressure on primary schools to raise standards in English and mathematics (literacy and numeracy), resulting in the driving out of non-essential aspects of the tested core curriculum and as a consequence science had lost its position as a core subject of the primary curriculum.

There is considerable agreement among researchers that a culture of test preparation at KS2 has developed as the direct result of the high stakes nature of end of Key Stage assessment with publication of league table showing the percentage of pupils achieving Government target levels in core curriculum subjects. Evidence of this can be seen in the burgeoning market in commercially produced revision resources (Black, 1995; Brown *et al.,* 1996; Clarke, 1996; Ellis, 1997; Wiliam, 2001; Sturman, 2003).

In their 1995 report on KS2 tests in English, mathematics and science, the Schools Curriculum and Assessment Authority (SCAA, 1996) stated that between 78% and 83% of Y6 teachers offered advice to pupils on test techniques. In 1996 the percentage rose to 93% (QCA, 1999). However, Dann (1999), in her study of test preparation at KS2, found no clear indication of the nature of test preparation in core curriculum subjects in reports published by SCAA or the QCA during the 1990s, though Clarke (1996) suggested that KS2 teachers viewed test preparation for science as 'revision of factual knowledge' (p. 16).

In their exploration of effective school leadership, Hopkins *et al.* (2003) maintained that test preparation adversely affected the whole of the KS2 curriculum in England, as pupils were unlikely to engage in activities outside the classroom such as field trips for science, drama productions or any activity that might distract attention from the main goal of revision of the core curriculum. This is a view shared by Wiliam (2001; Wiliam *et al.,* 2004) who argued that formal summative assessment focused on the outcomes of learning, contributing little to pupils' learning. As a result teachers and pupils tended to focus only on what was to be assessed, creating a spiral in which only those aspects of learning that are easily measured are considered important.

This view is echoed by Sturman (2003) who, in exploring the approaches of 64 Y6 teachers to test preparation, found no evidence to show that time spent on test preparation in science was effective in enhancing pupils' knowledge and understanding in science, or their level of attainment at KS2. On the same point, an earlier study of the impact of KS2 tests on pupils and teachers (Brown *et al.,* 1996), found that half the teachers involved in the study believed that test preparation had a positive influence on pupils' test scores. However no evidence was offered to support this belief and it is not clear whether the remaining 50% of teachers involved in the survey believed test

preparation to have no influence on test outcome. While there is no direct evidence to show that test preparation results in higher test scores, Black and Wiliam (1998) presented research evidence to show that use of formative assessment for learning at KS3 and 4 led to gains in test scores, though with the caveat that the outcome is dependent on the quality of assessment, the feedback given to pupils and the opportunities provided for individual pupils to focus on aspects of difficulty. Although Black and Wiliam conceded that some gains might have been the result of teachers 'teaching to the test', they insisted that their findings showed that test preparation underpinned by effective formative assessment practices, and designed specifically to reinforce understanding, might result in valid gains.

Johnston and McClune (2000), in their study of 63 P6 pupils across 22 schools in Northern Ireland (NI P6 equivalent to Y6 England/Wales) found that high stakes Transfer Tests and the nature of test questions led teachers toward transmission teaching with an emphasis on factual knowledge. The authors highlighted their view of pupils' learning associated with such practice as:

> … gathering, processing and utilising factual knowledge, asking and answering of questions and as something which can be demonstrated through detailed and factually accurate written outcomes. (p. 1)

Teachers might therefore value precise/sequential processing approaches to learning more than other approaches. This to say that those pupils who learn more effectively through hands-on practical (technical processing) activities in science – said to be the most common learning disposition among KS2 pupils – or those whose learning is enhanced through an independent and/or problem-solving (creative/divergent) approach to learning might be disadvantaged as a result of such test preparation. It is suggested that such teaching strategies might discriminate against and demoralise pupils whose preferred learning style is at odds with approaches to science teaching with concomitant impact on pupils self-esteem and motivation.

Three recent studies have explored teachers' views of test preparation. Respondents to Sturman's (2003) survey of 64 KS2 teachers expressed dissatisfaction at the amount of time needed to prepare pupils for national tests in Y6, with half reporting that 'normal science activities' (p. 264) were replaced by test preparation materials in at least some science lessons throughout the year, a finding mirrored in Jurd's (2000) study of the effects of national tests on teaching in Y6. Sturman (2003) reported that while the majority of teachers in her sample focused on the Science National Curriculum programmes of study Sc2, Sc3 and Sc4, all teachers claimed to revise subsections of Sc1, *Scientific Enquiry.* She concluded that responses showed a determination among Y6 teachers to emphasise understanding in science, rather than simply focusing on enhancing pupils' chances of scoring well in tests. However, where investigations were used for revision of Sc1, Sc2, Sc3 and Sc4, Sturman found that these tended to be 'given' by the teacher rather than developed from pupils' own ideas where they might be encouraged to develop tests to investigate a question of their own. In addition

to time constraints, teachers also cited the need to organise and prepare resources in advance of science lessons as a reason for structured, teacher-led investigations, though teachers acknowledged that this served to diminish opportunities for the development of pupils' knowledge and understanding of the ways in which scientists devise and test their ideas.

Other teaching strategies associated with tests preparation among Y6 teachers included:

- Reading test questions for 'clues' about the amount of text space for answers to guide the level of details required
- Practice in timing and pace of writing answers to test questions
- Ticking the required number of boxes in multiple choice questions
- Using scientific vocabulary and reading
- Interpreting information from tables or graphs
- Quizzes, discussion and homework.

(Emery *et al.,* 1998; Patterson, 1999; Jurd, 2000; Sturman, 2003)

Wiliam (2001) argued that if teaching to the test was to be prevented it would be necessary to separate the evaluation of the school from pupils' test scores. Instead of moving toward the publication of the results of moderated teacher assessment, schools would be held accountable by the results of special tasks taken by pupils at the end of each Key Stage. Crucially, there would be a large number of these tasks and not all pupils would undertake the same one. It was envisaged that tasks would cover the entire syllabus and would be allocated randomly, so there would be no chance of teaching to the test. Or more precisely, the only way to teach to the test would be to teach the whole curriculum to every pupil. Wiliam maintained that the results of such tests would have the added benefit of providing a check on teacher moderation procedures and would ensure accurate information on the real state of education in primary and secondary schools was submitted to policy makers.

Primary-secondary transfer

In a study of primary-secondary transfer Galton *et al.* (1999) surveyed 215 secondary schools in an effort to identify areas in which action had been taken to improve continuity and progression from primary to secondary schools since the implementation of the National Curriculum in 1989. Findings showed greatest progress had been made in areas of *bureaucratic* and *social and personal* areas of action. Areas where least action had been taken was in *curriculum* – for instance, joint project work, focused training days – and in *pedagogic* areas – such as teacher exchanges and joint programmes to develop specific approaches to teaching, e.g. the development of thinking skills in science.

In discussing proposed changes to assessments arrangements in Wales, Jane Davidson, Welsh Assembly Minister for Education, reported that secondary schools utilised commercial, diagnostic tests because national test results at KS2 were found to be unreliable in providing the information they needed about pupils' learning and levels of attainment (Budge, 2006). This view is supported by a number of studies that identified high levels of distrust of assessed levels of attainment in science at KS2 among secondary teachers

who believe that pupils' levels are artificially inflated by intensive test preparation and revision (Ellis, 1997; Bunyan, 1998; Collins, 1999; Nicholls & Gardner, 1999; Schagen & Kerr, 1999; Braund & Hames, 2005).

In England, a consistently high percentage of pupils achieve the target level (level 4) or above in science national tests at KS2 – between 2000 and 2007 the percentage was between 85% and 88% (DCSF, 2007). In 2001 87% of Y6 pupils in England achieved level 4 or above in national science tests. Three years later in 2004 when these same pupils reached the end of KS3 the percentage gaining the target level (level 5) in national science tests had dropped to 66% (DfES, 2005). These data were interpreted by Braund (2005) as a regression in pupils' progress in science, or at least a failure to make expected progress. However, Moody (2001), in his exploration of predictive validity and reliability of national tests at KS2 and teacher assessment for target setting at KS3, argued that levels of attainment stated for pupils at the end of KS2 were not equivalent to the same levels at KS3, making an estimation of pupils' progress through KS3 problematic for teachers. This was compounded when the level of attainment was relatively high, for example level 5, which a pupil might be expected to attain by the end of KS3.

Braund *et al.* (2003) provide some support for this claim in reporting primary and secondary teachers' views of approaches to the teaching and assessment of science. In response to a statement suggesting that level 4 in science at KS2 was the same as level 4 at KS3, 51% of primary teachers (n=71) and 56% of secondary teachers (n=82) rated the statement as 'false'. The near equal split in opinion was reflected in advice to tutors using the training pack accompanying *The KS3 National Strategy* (DfES, 2002), where it was suggested that statements referring to the equivalence of levels of attainment might be rated:

> … True and False. There are conceptual aspects of Level 4 that are exactly the same in Key Stage 3 as they are in Key Stage 2. However, the content of the Key Stage 3 programme is different to that in Key Stage 2. Detailed discussions about these subtle differences can be unhelpful and can distract from building on what pupils already know and can do. (p. 15)

The current situation concerning teachers' perceptions of equivalence of levels at KS2 and KS3 remains far from clear however, as responses to a further question put to primary and secondary teachers by Braund *et al.* (2003), which asked specifically whether level 4 in the Science National Curriculum *Scientific Enquiry* (Sc1) programme of study at KS2 was the same as level 4 in Sc1 at KS3, showed that 62% of primary and 55% of secondary teachers agreed that this was the case. Probes by the research team helped to explain teachers' reasoning. On the one hand they reasoned that as levels of skills in scientific enquiry represented ways in which pupils applied decisions and strategies to a given problem, independent of the context and/or conceptual demands of the activity, they should be judged on their own merits. On the other hand teachers felt that the context, procedures and conceptual demands of activities in science changed between KS2 and KS3; therefore the interpretation of ways in which pupils applied scientific skills would inevitably be different.

In an attempt to improve collaboration and cooperation between primary and secondary schools *The KS3 National Strategy* articulated a clear commitment to improving progression in pupils' learning in the three core curriculum subjects of English, mathematics and science between Key Stages (DfES, 2002). To this end the government has financed a number of 'bridging projects' for science, though as yet there are no evaluations of the longer-term effects of such projects on progression and continuity in pupils' learning in science during transition from primary to secondary education. Braund and Hames (2005) achieved some success with their trials of bridging materials, reporting that attitudes towards science among Y6 pupils improved as a result of involvement with the bridging project and this was maintained during the first term following transfer to secondary school. This is an important consideration given ongoing concerns about the decline in pupils' attitudes towards science at KS2 and KS3 (Pell & Jarvis, 2001; Galton *et al.,* 1999, 2003a, 2003b).

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Appendix 2

Telephone survey instrument and focus group schedule for England and Wales

Telephone Survey Instrument: Effects of Compulsory National Testing in Science at KS2 – Ipsos MORI

Introduction

Good morning/afternoon. My name is XXX and I am calling from Ipsos MORI, the independent research organisation. We are carrying out a survey on behalf of the Wellcome Trust in partnership with the Institute of Education, University of London.

We would like to explore the views of Year 6 teachers, primary science coordinators and primary head teachers in England and Wales about the effects of statutory testing and teacher assessment at Key Stage 2 on teachers and the teaching of science. The interview will take about 10 minutes.

I would like to reassure you that everything you say during the course of this interview is entirely confidential and will not be reported in a way that can identify either individuals or individual schools.

Background information

Q1 Which of the following describes your position at the school?
Headteacher
Science co-ordinator
Year 6 class teacher

Q2 How many years of teaching experience do you have?
NQT/first year of teaching
1-5 years
6-10 years
11-15 years
16-25 years
More than 25 years

Teaching science in Year 6
Q3 How much time on average is spent teaching **science each week** in each Year 6 class in your school?

Less than 1 hour
1-2 hours
3-4 hours
4-5 hours
More than 5 hours
Don't know

Q4 I am going to read out some strategies that may be used to teach science. Please tell me how often, if at all, they are used to teach science in Year 6 in your school?

a) Teaching science from stories
b) Teacher demonstrations
c) Investigations
d) Other practical work
e) Relating science to everyday life
f) Whole class discussions
g) Group discussions
h) Developing thinking skills in science
i) Group work
j) Field trips
k) Integrating science with other subjects
l) Teaching science through drama and role-play

Often
Sometimes
Rarely
Never
Don't know

Developing pupils' science skills in Year 6

Q5 I am going to read out a number of skills associated with learning science in Year 6. Please tell me how often these form part of pupils' learning in Year 6 science lessons.

a) Recognising, designing and carrying out a fair test
b) Observation
c) Independent recording of data
d) Interpreting findings
e) Working in groups
f) Considering ways in which science might affect their lives

Often
Sometimes
Rarely
Never
Don't know

Q6 In your view, what are the main challenges facing Year 6 teachers in the teaching of science in your school? PROBE FULLY.
WRITE IN VERBATIM
None
Don't know

Forms of assessment used in Year 6 in your school

Q7 I am going to read out a number of types of summative assessment. Please tell me which, if any, are commonly used in science in Year 6 in your school.

a) Practice papers from published schemes of work
b) Past SATs papers
c) School-based written tests
d) Teacher review of assessed work
e) Checklists to record observations of pupils
f) Something else? Please specify.

Q8 And now I am going to read out a number of types of formative assessment. Again, please tell me which, if any, are commonly used in science in Year 6 in your school.
a) Discussing learning intentions
b) Discussing success criteria
c) Feedback without marks to pupils with advice for improvement
d) Self assessment
e) Peer assessment
f) Something else? Please specify.

Views of Year 6 summative assessment in science

ASK OF TEACHERS IN WALES ONLY

Q9 What effects, if any, has the abolition of end of Key Stage 2 statutory testing had on the teaching of science in Year 6 in your school? PROBE FULLY.
WRITE IN VERBATIM
No effects
Don't know

ASK OF TEACHERS IN ENGLAND ONLY

Q10 In what ways, if any, do you think the teaching of science in Year 6 would change in your school if SATs were abolished in favour of teacher assessment? PROBE FULLY.
WRITE IN VERBATIM
No effects
Don't know

Q11 I am going to read out a number of statements about assessments. Please tell me to what extent you agree or disagree with each of the following.

ASK ALL

a) There is enough time in Year 6 for practical work in science
b) Moderated teacher assessment gives a more accurate picture of what pupils know, understand and can do than SATs results
c) Preparation for tests dominates the teaching of science in Year 6
d) Year 6 pupils' SATs scores are more helpful for secondary science teachers than teacher assessment

ASK OF TEACHERS IN ENGLAND ONLY

a) If Year 6 pupils were no longer required to take science SATs, teachers should still use optional test materials rather than rely on teacher assessment alone

ASK OF TEACHERS IN WALES ONLY

a) Even when Year 6 pupils are no longer required to take science SATs, teachers should still use optional test materials rather than rely on teacher assessment alone

- Strongly agree
- Tend to agree
- Neither agree nor disagree
- Tend to disagree
- Strongly disagree
- Don't know

Q12 And now I am going to read out a number of statements about the links between assessments and standards. Please tell me to what extent you agree or disagree with each of the following.

ASK OF TEACHERS IN ENGLAND ONLY

a) National science assessments adequately reflect school performance in science

ASK OF TEACHERS IN WALES ONLY

b) Removing Key Stage 2 science tests has improved standards of attainment in science in Year 6

ASK ALL

c) Achievement and attainment tables based on Key Stage 2 test results, give parents and others vital information about teaching and learning in a school
d) Teachers and schools should not be judged by achievement and attainment tables of assessment results

Strongly agree
Tend to agree
Neither agree nor disagree
Tend to disagree
Strongly disagree
Don't know

Q13 And finally, what is your highest qualification in science?

GCSE
A-Level
First degree
Masters/PhD
Other
Don't know

Re-contact

Q14 Researchers from the Institute of Education, University of London are conducting some further research on related issues in your area over the next two months. Would you be interested in taking part in a group discussion about these issues? You would receive a £20 voucher as a thank-you for your time.

Q16 INTERVIEWER TO RECORD GENDER

Male
Female

THANK YOU AND CLOSE

Focus Group Schedules

Each focus group will begin with a short introduction to the project – aims and purposes. The process of the focus group discussion will be explained. **Individual introductions** – to include participant's name, school, number of years in teaching and number of years teaching in Y6/science coordinator. A first, general question will be used as an icebreaker to encourage everyone to speak for the first time.

Year 6 teachers and primary science coordinators

1. *(Identify science coordinator and Y6 teacher(s) from one school)* **Take us through a typical recent science lesson**
   Probe:
   a. Was this typical in terms of practical work, data collection, group work?
   b. How does this match with the experiences of others?
   c. Do science coordinators share the same views – if different expectations, what are they?

2. **If you had complete freedom would you do anything differently to what you do now in science in Y6?**
   Probe:
   - What? Why?
   - Draw out current and preferred teaching strategies
   - Draw out ways in which pupils' science skills are and might be developed in lessons

3. **What are the main challenges facing Y6 teachers in the teaching of science?**
   Probe:
   - Are the challenges unique to science? In what way(s)?

3. **England only**
Do you prepare pupils for science SATs?
Probe:
   - In what ways do you prepare pupils?
   - In what ways do the SATs shape what and how science is taught in Y6?

4. **England only:**
   A) **What do you see as the advantages of science SATs?**
   Probe:
   - What are science SATs asking of teachers?
   - What are they asking of pupils?

   B) **How do you respond to the suggestion that if science SATs were abolished all assessment should be teacher assessment?**
   Probe
   - What support might you need if teacher assessment replaced SATs?

Wales only:

A) Has the removal of KS2 national tests changed the teaching of science Y6?

Probe:

- Why not/In what way?
- What support have you received in making changes?
- To what extent has the removal of KS2 science tests affected standards of attainment in science in Y6?
- How might standards of attainment in science be improved at KS2?

B) How do you respond to the suggestion that now Y6 pupils are no longer required to take science SATs teachers should still use optional test materials rather than rely solely on teacher assessment?

Probe dependent on responses.

5. England only:

A) **How would you advise your Y6 colleagues to use the KS2 science test results to improve their teaching of science?**

Probe:

- How do *you* use science test results?

B) **How would you advise Y7 science teachers to use the information you prepare about each pupil's progress in science in KS2?**

Probe:

- How do Y7 teachers currently use the information you provide?
- How would you like to see this improved?

Wales only:

A) **How would you advise your colleagues to use results of teacher assessments to improve their teaching of science next year?**

Probe:

- How do *you* use science test results?

B) **How would you advise Y7 science teachers to use the information you prepare about each pupil's progress in science in KS2?**

Probe:

- How do Y7 teachers currently use the information you provide?
- How would you like to see this improved?

6. (Omit this question if short of time)

How much time is timetabled for science each week in Y6 in your school?

Probes for general discussion:

- How much of this time is spent teaching science in reality?
- Is this more, less or about the same as time spent on other subjects each week? English and mathematics?
- Why is more/less time spent on science than other subjects?

Head Teachers

1. **What do you think are the main challenges facing Y6 teachers in the teaching of science?**

   Probe:

   - In what ways are these challenges different to those faced by teachers in other year groups?
   - Are the challenges unique to science?
   - What particular challenges does science offer that other subjects do not?

2. **What types of assessment do you recommend for use in science in Y6?**

   Probe:

   - In what ways do Y6 teachers in your school use assessment for learning?

3. **England only:**

   A) **In what ways would you expect the teaching of science in Y6 to change if national tests were abolished in favour of teacher assessment?**

   Probe dependent on responses.

   B) **How do you respond to the suggestion that if science SATs were abolished all assessment should be teacher assessment?**

   Probe:

   - What support might your teachers need if teacher assessment replaced SATs?
   - If optional test materials for science were to be made available, what might they look like?

Wales only:

   A) **Has the removal of KS2 national tests changed what is taught in science and how it is taught in Y6?**

   Probe:

   - Why not/In what way?
   - What support have teachers received in making changes?
   - To what extent has the removal of KS2 science tests affected standards of attainment in science in Y6?
   - How might standards of attainment in science be improved at KS2?

   B) **How do you respond to the suggestion that now Y6 pupils are no longer required to take science SATs, teachers should still use optional test materials rather than rely solely on teacher assessment?**

   Probe dependent on responses

4. **England only:**

   What do you see as the advantages and disadvantages of national tests in science at KS2?

   Probe:

- To what extent do national science assessments reflect school performance in science?
- How would you like to see science assessment improved?

Wales only:

What issues need to be considered in utilising moderated teacher assessment to determine levels of attainment in science for every pupil in Y6?

Probe dependent on responses

5. **England only:**

How useful have you found the science SAT results in communication with parents?

Probe:

- What information do you provide to parents about pupils' progress and attainment in science?
- Is this sufficient?
- Is there another way this might be done?
- How would you respond to the suggestion that schools should not be judged by achievement and attainment tables of results?

Wales only:

What information do you provide to parents about pupils' progress and attainment in science?

Probe dependent on responses:

- What information do you provide to parents about pupils' progress and attainment in science?
- Is this sufficient?
- Is there another way this might be done?
- In what ways do the alternatives compare with previous methods of communication?

6. **How much time is timetabled for science each week in Y6 in your school?**

Probes for general discussion:

- How much of this time is spent teaching science in reality?
- Is this more, less or about the same as time spent on other subjects each week? English and mathematics?
- Why is more/less time spent on science than other subjects?

Finish discussion. Closing comments.

Secondary Teachers

1. **What information do you currently receive from primary schools about pupils' attainment in science?**

Probe dependent on responses:

- Are procedures same across partner primary-secondary schools?
- What information would be more useful to support teaching and learning of science in KS3?

- To what extent are you involved in decisions about the kind of information you receive from primary schools about pupils' levels of attainment in science?
- Probe partnership arrangements in England and Wales for similarities and differences

2. **Do KS2 attainment levels give accurate information about what pupils know, understand and can do in science?**
   Probe:
   - If not why not?
   - If not, how do you gather more accurate information?

3. **England only:**
   If SATs were abolished at the end of KS2 do you think Y6 teachers should still use optional test materials rather than rely solely on information based on teacher assessment?
   Probe:
   - Why?
   - What are the advantages of SATs?
   - What might be the advantages of information based solely on teacher assessment?

Wales only:
Even though Y6 pupils are no longer required to take science SATs, do you think Y6 teachers should still use optional test materials rather than rely solely on teacher assessment?
Probe

4. **Wales only:**
   Thinking about the abolition of KS2 statutory testing in science, have you noticed any differences in the level of pupils' scientific skills?
   Probe dependent on responses

5. **England only**
   In what ways would the teaching of science in KS3 change if science SATs were abolished in KS2 and KS3?
   Probe:
   - How would the abolition of KS2 science SATs affect teachers and teaching of science in KS3?

Wales only
Has the teaching of science in KS3 changed since the abolition of science SATs at KS2 and KS3?
Probe:
- In what ways has it changed?
- Is this change for the better?

Finish discussion. Closing comments.

Appendix 3

Characteristics of the telephone survey sample

The total number of respondents to the telephone survey was 600 – 300 from England and 300 from Wales in the following categories of position in the school:

- Headteachers – 100 from England and 100 from Wales
- Y6 teachers – 100 from England and 100 from Wales
- Primary science coordinators – 100 from England and 100 from Wales.

Length of service and gender

More than half of the headteachers in England and Wales had been teaching for more than twenty-five years (57%), while relatively few (8%) had been teaching for less than fifteen years. The highest percentage of Y6 teachers across the two countries had been teaching for less than six years (36%), with 8% having taught for between sixteen and twenty-five years. The length of service of science coordinators was evenly spread in England and Wales with approximately one quarter (24%) of science coordinators in England and Wales having taught between six and twenty-five years.

The percentage of male and female headteachers was similar in England (47% male, 53% female) and Wales (52% male; 48% female). Over two thirds of science coordinators in England and Wales were female (England 78%, Wales 71%), while males made up 22% of the science coordinator sample in England and 29% in Wales. Females dominated Y6 teaching in England and Wales, in England over half (74%) of Y6 teachers were female while in Wales 62% were female. This was in contrast to the percentage of male teachers in Y6 classes in England (27%) and in Wales (29%).

Highest qualification in science

Approximately one third of science coordinators in England (36%) and Wales (30%) had studied science to degree level, while in Wales 22% of Y6 teachers and in England 18% had a first degree in a science subject.

In England and Wales over half of all Y6 teachers (England 57%, Wales 55%) and nearly half of headteachers (England 49%, Wales 49%) had gained a GCSE or O level in science. In contrast to this 34% of science coordinators in England and 43% in Wales had studied science to GCSE or O level.

Amount of time on average spent teaching science each week in Y6 classes in England and Wales

Approximately two thirds of respondents across sub-groups in England and Wales estimated that science was taught in Y6 classes for between one and two hours each week. The percentages were:

England

- Headteachers – 73%
- Science coordinators – 75%
- Y6 teachers – 74%.

Wales

- Headteachers – 77%
- Science coordinators – 81%
- Y6 teachers – 82%.

Fewer than half of all schools represented taught science for an average of three to four hours each week. The percentages were:

England

- Headteachers – 24%
- Science coordinators – 24%
- Y6 teachers – 23%.

Wales

- Headteachers – 19%
- Science coordinators – 16%
- Y6 teachers – 17%.