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Ref:

Science and the revision of the National Curriculum

Summary

As part of the current review of the National Curriculum for the year 2000, the Royal Society, Association for Science Education, Institute of Biology, Institute of Physics, Royal Society of Chemistry, Engineering Council, Royal Academy of Engineering, Institution of Electrical Engineers, Geological Society and the Earth Science Teachers' Association urge the Government to take note of and act upon the following comments and recommendations regarding science provision for 14-16 year olds (Key Stage 4):

- Appropriate science courses make a vital contribution to the education of **all** pupils at Key Stage 4, both as developing citizens and as people who wish to use science in pursuing their careers.
- Given the extent of science, (biology, chemistry, physics, earth science etc.), it cannot in any sense be considered as only one curriculum subject in terms of content and time demands. Indeed, it might be more accurately referred to as "the sciences".
- The flexibility available to science teachers in developing science courses appropriate for the range of pupil abilities and needs should be increased.
- The sciences cannot be adequately taught to **any** Key Stage 4 pupil in less than 20% of curriculum time.
- The explicit recommendation that Key Stage 4 students should spend 20% of their curriculum time studying the sciences must be included in future drafts of the National Curriculum.
- The problems of under provision, and inequality of provision between the sexes, which were all too apparent before the National Curriculum, will return if a significant number of Key Stage 4 pupils are allowed, or indeed expected, to spend less than 20% of their curriculum time on science.

This statement, prepared by the Royal Society, is endorsed by the ten organisations listed above which together represent over half a million members of the science and engineering community, including teachers, headteachers, teacher educators, industrialists and academics.

Introduction

In line with the time-scale recommended by the last review of the National Curriculum in 1993^{Error! Bookmark not defined.}, the Qualifications & Curriculum Authority (QCA) is currently engaged in a review of the Curriculum on behalf of the Government. Part of this current review involves a detailed look at the whole of the Key Stage 4 curriculum^{Error! Bookmark not defined.}, with a view to making it more flexible and more suited to the needs of all pupils. The new, revised, National Curriculum will be implemented in schools from September 2000.

In its detailed advice to the Secretary of State on Key Stage 4, the Qualifications & Curriculum Authority identifies that, *"By Key Stage 4, pupils needs, interests and levels of attainment have diverged significantly. The demands on the Key Stage 4 curriculum are accordingly distinctive. The curriculum needs to link clearly with the changing opportunities and demands of post-16 education and training and help to provide pupils with attitudes and skills needed to become lifelong learners. ... In particular the case for statutory design and technology and a modern foreign language post-14 should be reviewed, and a fresh look should be taken at the range of options permitted for science"*^{Error! Bookmark not defined.}

At present the options permitted for science^{Error! Bookmark not defined.} in Key Stage 4 are given by the National Curriculum as: *"Pupils may be taught either double or single award science at Key Stage 4. The requirements of either option would also be met by pupils taking GCSE courses in all three of the separate sciences of biology, chemistry and physics. The Government firmly believes that double science or the three separate sciences should be taken by **the great majority of pupils**. Single science is intended for a minority of pupils who have good reason to spend more time on other subjects."*^{Error! Bookmark not defined.} (our emphasis).

In September of this year, following due consultation, the Secretary of State laid before Parliament regulations which change the above situation for a small minority of pupils whose disaffection with school is most dramatically demonstrated by their persistent, and sometimes total, absence from school during Key Stage 4.^{Error! Bookmark not defined.} The regulations allow schools to apply for dispensation to disapply or modify the National Curriculum to exempt these pupils from the National Curriculum Orders for not more than two subjects chosen from modern foreign language, design and technology and science.

Science 14-16

The contribution science makes to a balanced curriculum is essential and unique. School science provides pupils with a knowledge of the natural world, the skills of investigation and experimentation and an appreciation of the importance of science to individuals and to society. Science also develops such personal skills as curiosity, motivation, teamwork and the ability to communicate. These are widely recognised as particularly important skills and values, both in science and as part of a broader education. They help prepare pupils for further study and for a broad range of careers, as well as providing a basis for informed citizenship.

The word 'science' is used as a shorthand to include biology, chemistry and physics as well as earth science, all of which are included in the science National Curriculum. Pupils must have this broad and balanced view of science; without this breadth, pupils are left with an inadequate grasp of science and an unbalanced school

curriculum. The fact that 14 year old pupils have studied science for all of their school lives does mean that they will know more science than pupils of their age did before the National Curriculum was introduced. But, for reasons of maturation, pupils at the end of Key Stage 3 will still not have experienced the range of science experiences which are necessary for their full development as caring, informed citizens.

Pupils in Key Stage 4, of whatever ability, bring an increasing maturity to their studies which enables important areas of science (such as genetics) to be introduced to them. It also allows them to appreciate more of the concepts concerned with the nature of science itself such as the role of evidence. The crucial issues of how scientific advances impact on society and how society takes account of scientific evidence in making decisions are also able to be dealt with at significantly greater depth during this Key Stage. **In order to have adequate experiences of all aspects of science which can successfully contribute to their development, pupils at Key Stage 4 need to spend at least 20% of curriculum time studying it.** How this 20% of curriculum time is used should vary with the abilities, motivation and background of pupils. Some pupils will benefit from courses where links with other subjects, such as technology, can be fully exploited and where opportunities to apply their developing science knowledge in real work situations will be of value. Some pupils will not be able to attempt any GCSE examination and will look to alternative forms of certification to record their progress. Others will decide to enter for double award science and still others, who have spent up to 30% of their time on science, will enter GCSEs in the separate sciences. Despite all the differences in provision, the extent of science, and therefore of its contribution to the full development of all pupils, means that science cannot be adequately taught to any Key Stage 4 pupil in less than 20% of curriculum time.

As the regulations exist and are interpreted by schools at present, a small minority of pupils, (around 8%), spend significantly less than 20% of their time on science in Key Stage 4. This is for a variety of reasons, and although it is to be regretted, for this minority of pupils special circumstances make it very difficult to effect any significant change. However, the vast majority, some 80% of Key Stage 4 pupils, do spend around 20% of their total curriculum time on science. This is partly through choice, but crucially also because of the Government's expectation that "*a great majority*" will do this. The current situation, with a large majority of pupils spending 20% or more of their time studying science has only been achieved for the few years since the National Curriculum came to be fully implemented. The enormous benefits to society of this necessary level of Key Stage 4 science education will only slowly become apparent.

We believe that a review of the Key Stage 4 National Curriculum could usefully tackle the needs of the least able and the least motivated. **Teachers require greater flexibility to use their knowledge of these pupils to choose an appropriate pace of teaching and create experiences which make material relevant in ways which pupils can appreciate.** The large majority of pupils, who are reasonably well served in terms of breadth and balance by the current curriculum, would also benefit from teachers being given increased flexibility to design courses which enabled pupils to study up-to-date applications in more detail and to pursue their particular local and personal interests *via* extended project-type investigations. A recent OFSTED review of school inspection findings produced evidence that "*...whereas their knowledge of the material in the programmes of study has improved, pupils' understanding of underlying scientific concepts frequently remains*

*insecure and they are insufficiently able to apply their knowledge in new contexts"*⁷. This also suggests the current secondary science curriculum does not allow teachers to give pupils enough opportunity to apply their knowledge, for example through project work and longer-term investigations.

Endpiece

Much of the content of this statement is not new; the organisations endorsing it, and others, have publicly stated their support for these recommendations several times in the past. It is indicative of the importance we place on these issues that we now re-state broad principles relating to science education. The review of the National Curriculum provides all of us with an opportunity to examine in depth issues facing school science and education in general. Several issues have evolved, and changed in priority, since the last review of the curriculum. The recognition of "citizenship" as an important component of school education, the cross-curricular relationship of science and other subjects and the development of information and communications technology (ICT) are just three of many such important issues. All of the organisations endorsing this statement are actively involved, both individually and collaboratively, with the review of the National Curriculum and each organisation will continue to offer advice to the Government in their own area as the review progresses. Thus this statement should be regarded only as the first step of an ongoing process of the science community making its views on the review of the curriculum publicly known. Further statements, dealing in depth with more specific issues relating to school science, will be issued as the review progresses.

Observations and recommendations

- 1 Appropriate science courses make a vital contribution to the education of all pupils at Key Stage 4, both as developing citizens and as people who wish to use science in pursuing their careers.
- 2 Given the extent of science, (biology, chemistry, physics, earth science etc.), it cannot in any sense be considered as only one curriculum subject in terms of content and time demands. Indeed, it might be more accurately referred to as "the sciences".
- 3 The flexibility available to science teachers in developing science courses appropriate for the range of pupil abilities and needs should be increased.
- 4 The sciences cannot be adequately taught to any Key Stage 4 pupil in less than 20% of curriculum time.
- 5 The explicit recommendation that Key Stage 4 students should spend 20% of their curriculum time studying the sciences must be included in future drafts of the National Curriculum.

6 The problems of under provision, and inequality of provision between the sexes, which were all too apparent before the National Curriculum, will return if a significant number of Key Stage 4 pupils are allowed, or indeed expected, to spend less than 20% of their curriculum time on science.

Notes and references

1. The National Curriculum was established by the Education Reform Act of 1988 and specifies the subjects, programmes of study (what pupils should be taught), and attainment targets (the expected standard of performance), for pupils of compulsory school age in maintained schools. Following a review of the National Curriculum in 1993, a new, slimmer and more flexible version of the Curriculum was introduced from September 1995. The review also made the recommendation that no further major changes should be made to the National Curriculum for five years.
2. The National Curriculum is organised on the basis of four Key Stages, broadly defined as:
 - Key Stage 1: 5-7 year olds
 - Key Stage 2: 7-11 year olds
 - Key Stage 3: 11-14 year olds
 - Key Stage 4: 14-16 year olds
3. "*Developing the school curriculum*". Qualifications & Curriculum Authority, April 1998.
4. Single award science courses lead to one GCSE qualification and are currently followed by only around 8% of pupils. Over 80% of pupils follow double award courses leading to the award of two GCSEs. Both single and double award courses cover the subject areas of biology, chemistry, physics and earth science.
5. "*The National Curriculum*". Department for Education, January 1995.
6. "*National Curriculum: regulations to permit the wider use of work-related learning at Key Stage 4*". Department for Education & Employment, September 1998.
7. "*Secondary education: a review of secondary schools in England 1993-97*". OFSTED, 1998.