

Science education from 14 to 19

Submission of evidence to the House of Commons Science and Technology Committee Inquiry

February 2002

Introduction

1 This statement outlines core principles regarding science education 14-19 and is submitted jointly by the following organisations:

- The Association for Science Education;
- The Institute of Biology;
- The Institute of Mathematics and its Applications;
- The Royal Society;
- The Royal Society of Chemistry.

In addition to this statement, some of the organisations listed above may submit additional evidence to the Inquiry where this is pertinent to their particular remit or subject area. The organisations would respond positively to requests from the Committee to provide further oral or written evidence, either individually or as a consortium.

2 We welcome the opportunity to submit evidence to this timely inquiry and also look forward to informing the forthcoming DfES review of the 14-19 curriculum. Whilst acknowledging the favourable light in which science education in the UK is shown by recent international surveys, we value the opportunity to contribute to inquiries aiming to enrich students' experience of learning science.

3 We welcome the Committee's desire to identify and address existing problems in order to progress the curriculum to one which addresses the needs of all and assumes greater relevance to pupils' everyday lives. The original introduction of the National Curriculum was beneficial in many ways, but the numbers of students continuing with mathematics and the sciences post 16 have lagged behind the average increase in numbers continuing their studies beyond age 16 in recent years. Research studies¹ have shown that the science taught from 11 to 16 in secondary schools, which has largely been dominated by the educational needs of future scientists, often turns students away from science. The focus on the theoretical background and content of the sciences has not resulted in scientific literacy and is perceived by students, both those inclined to science and those not, as being largely unrelated to the science that they experience in everyday contexts. The current curriculum fails to prepare students to engage with science from a citizenship perspective and also fails to inspire and challenge many who have the ability to continue with science-based studies. As a basic entitlement for all students, science education 14-19 should enable them to develop their understanding of key areas of science in relation to the ways in which it affects their lives, society and world in which they live. It must of course also provide an appropriate grounding for those students wishing to continue with science study beyond 19, and this grounding must include an appreciation at an early stage that the rest of society will rightly take an interest in what scientists do and why they do it.

The approach to science teaching

4 We welcome recent initiatives such as the Key Stage 3 Strategy in Science and QCA's proposals for keeping science in step with the 21st Century and believe that these should be built upon. We commend the introduction of the AS qualification in the Public Understanding of Science and similar post-16 concepts, particularly for those not otherwise continuing with further study in science.

¹ Osborne J & Collins S, 2000 'Pupils' & Parents' views of the School Science Curriculum' and Osborne et al, 2001 'What should we teach about science?'

- 5 The ability to acquire, interpret and use information to engage in debate and solve problems is more pertinent in today's world than the ability to recall facts. Pupils enjoy science practical work but OFSTED evidence and QCA's ongoing monitoring of the National Curriculum indicate that pupils' experience of attainment target Sc1 ('Scientific Enquiry') at Key Stage 4 is too repetitive and narrow, with little time spent on the 'ideas and evidence' strand. Many students leave Year 11 with the impression that science is about learning the right answers, with little room for conjecture or creativity. The current structure of the curriculum is not conducive to making science exciting and relevant. The amount of practical work has declined due to the content overload of the curriculum; whilst Health & Safety legislation is often cited by teachers and others as preventing some practical work in schools, (including some of the more exciting and visual demonstrations), we consider this view to be erroneous.
- 6 Furthermore, there is frequently insufficient time to consider topical issues, pupils' particular interests or the links between topics, both within and across the sciences. Consequently, for too many, science in the classroom may appear confusing, dull or insufficiently challenging, leading pupils not to continue with science studies post-16. The Key Stage 3 Science Strategy aims to raise awareness of the need to engage pupils in 'real' science; the student experience at Key Stage 4 and beyond needs to build on this.
- 7 Pupils should have the opportunity to explore areas of interest and be enabled to make productive links between the sciences, technology and mathematics. We believe this would be best facilitated at a local level, by ring-fencing time in the school week in which teachers of science, mathematics and design & technology have opportunities to discuss with one another potential links between the programmes of study and time to plan and implement teaching and learning strategies which support such links.
- 8 Students differ in their interests, career intentions and ways of learning. They should be allowed to direct their own learning to a greater extent in order to choose pathways building on the minimum entitlement and to learn in ways and at a rate that suits them. Parity of esteem must be given to academic and vocational qualifications to encourage students to choose a route appropriate to their aspirations and interests. Enhanced counselling and careers advice must be provided.

Assessment

- 9 UK assessment systems are predominantly examination based. The curriculum is being driven and shaped by assessment demands rather than aims of understanding. This has led to 'teaching to the test' and widespread use of a 'recipe' approach in teaching experimental skills in science. We are conscious that QCA, SQA, etc maintain standards rigorously and that exam specifications include the testing of skills and understanding, but we consider that alternative assessment methods could make a valuable contribution. More use should be made of the skilled judgement of professional teachers. Open-ended investigative work, particularly of a long-term nature, should also be promoted as the most appropriate way of engendering in pupils experimental and investigative skills.

Conclusion

- 10 Science should be a part of the core of studies for all in the 14-19 curriculum but the science experience must enhance the quality of students' interaction with science and contribute to their overall education. In order to do so we urge that consideration be given to the following points:
 - To present science as a subject for the 21st Century, modern equipment and techniques should be available and first hand experience of research and industrial science encouraged through meetings with scientists, placements, etc should be encouraged.
 - The Government should seek to reduce class sizes to no more than 20 students for secondary practical science. This would allow for classroom management more favorable to practical work.

- Adequate technical support from well-trained science technicians who have accessible CPD within their career structure is essential², as is adequate time allocation to engage in practical work, open-ended investigations and discussion of topical issues / students' interests.
 - Sufficient teachers who are well trained and confident are crucial. Teachers should be encouraged and enabled to keep up to date with their pedagogical and subject knowledge on a continuous basis and accredited for it. More trust ought to be displayed in teachers' professional judgements, eg. with respect to alternative forms of assessment. We welcome the Government's commitment to CPD and attention to issues such as teacher workload. We believe it is of paramount importance in addressing teacher retention.
 - Adequate amounts of high quality careers guidance must be available to all students.
 - Assessment and accreditation frameworks that strike an appropriate balance between rigour and flexibility are required; they should allow any learning activity of value contribute towards the students' recorded achievement.
 - We encourage the Committee to investigate the cost (per pupil) of the current assessment arrangements and compare this critically with the overall resources dedicated to each pupil's learning.
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² See the Royal Society / ASE report '*Supporting Success: science technicians in schools & colleges*' (2002) for a full analysis of the situation.