# Response to the professional bodies' articles on developing UK science curriculum frameworks

*John Holman*

**Abstract** In this response, I welcome the work of the Royal Society of Biology, the Royal Society of Chemistry and the Institute of Physics in developing curriculum frameworks for their subjects. I point out some of the challenges: in particular, there is a fine balance to be drawn between maintaining the integrity of the three sciences, and seeking coherence in the way the curricula are presented, and the way they deal with areas of overlap and common themes. This points the way to further joint work that needs to be done by these three bodies if these curriculum frameworks are to have the national impact they deserve.

## Why is this a good thing to do?

I welcome this exercise by the professional bodies to develop curriculum frameworks for the three sciences that can be applied across England, Northern Ireland, Scotland and Wales. I have just finished a two-year stint as President of the Royal Society of Chemistry and I have followed the curriculum work with much interest – and as President-Elect of the Association for Science Education (ASE), my interest will continue.

The organisations that know best about modern science, its frontiers and its underlying principles are the professional bodies for its three main disciplines: the Royal Society of Biology (RSB), the Royal Society of Chemistry (RSC) and the Institute of Physics (IOP). These professional bodies are here for the long term. The RSC, for example, has recently celebrated its 175th anniversary. Not only are the professional bodies in an authoritative position to define the school curricula for their disciplines: while governments come and go, they will still be there to oversee the curriculum and develop it to meet the changing face of their disciplines. This should not be a one-off exercise.

The RSB, RSC and IOP are respected bodies whose membership includes academic and industrial scientists from across the whole range of science. They collectively know the dynamic frontiers of science. They work closely with schools and schoolteachers and understand the realities of modern schools. They are trusted by academics and employers to accredit university degree courses in their discipline; the RSC, for example, accredits over 400 university chemistry courses in the UK and overseas. This position of trust and respect means they can be sturdy guardians of science in schools.

The timing of this exercise is good. No one is asking for changes to the science curriculum now, least of all in England, which has just gone through the recent revisions to A-level, GCSE and the National Curriculum. Curriculum change is hugely disruptive to schools and should never be undertaken lightly (present and future education ministers please note). Thinking, planning and changing schemes of work takes time that teachers could be using to plan great and inspiring lessons.

But science is always changing, and the time will come when a new curriculum *is* needed. That time might be five or more years away, but, when it comes, the professional bodies should be ready with the foundations of robust, modern curricula in the three major sciences. And they can be ready, from that point on, to work closely with teachers to keep the curricula continuously updated.

## Are we ready yet?

These articles show that the three sciences each have a credible foundation, developed by experts from academia, industry and education with the authority to specify the fundamentals of the curriculum in each subject. Is that enough, or is there more to do?

### *The nature of science*

It is clear from the articles that the professional bodies have approached their tasks in different ways. For example, the detail of specification of content is greater in biology and to some extent in chemistry, than in physics. There are differences in the approach to the nature of science in the three disciplines. Does this matter?

Perhaps not as much as you might think. For one thing, such differences can be reconciled and rationalised at a later stage (see *What next?* below). For another, there are significant differences between the three sciences, and it is best to recognise these.

I was a member of the group that created the original National Curriculum for science in England and Wales in 1988, and we knew we had a great opportunity ahead of us. '*Bliss was it in that dawn to be alive, and to be young was very heaven!*' as Wordsworth said, admittedly of the French Revolution. The 1988 National Curriculum didn't end quite as badly as the French Revolution, but it did need to be revised several times thereafter. Part of the problem was that there was simply too much content to fit into the available teaching time – a cautionary tale for those coming after. Another was that the underpinning model of the nature of science that we eventually arrived at was one that works better for physical than biological sciences.

## A common approach?

The three sciences are different and for that reason, we should not necessarily worry too much about having a common approach to presenting the curricula. This is especially true post-16, where the subjects already diverge quite significantly in the way they are presented at A-level. This divergence should be preserved and celebrated.

But in the lower end of secondary schools, and especially in primary schools, divergence can be unhelpful. So an important piece of work that remains is for the three professional bodies to work together to agree a common approach.My feeling is that this mainly needs to be done for key stages 1, 2 and 3, corresponding to the statutory National Curriculum. If these curricula are going to be useful to teachers in these phases, the professional bodies should work together to agree a unified approach to:

- specifying and assessing the nature of science;
- presenting content;
- dealing with crosscutting themes.

Many of the great themes of science – energy and the particulate theory, for example – are to be found in all three sciences, but they may be presented in different ways and in a different order in the three sciences. The challenge is to find a common approach that recognises the differences but does not confuse the learners. For example, molecular biology lies at the intersection of chemistry and biology. Biology teachers and chemistry teachers both use the language of chemical formulae, and they can support and reinforce one another if they adopt a shared approach.

It is essential that the professional bodies agree not only a common approach to such crosscutting themes, but also agree the order in which they are presented across the three sciences.

## Primary science

One of the big achievements of the 1988 National Curriculum for science in England and Wales was to create a national framework for science in primary schools, where none had existed before. No longer should secondary schools assume that pupils had done no science at primary school, because the statutory requirement of the National Curriculum gave continuity between primary and secondary. This led to what many would say was a golden age for primary science, reinforced by the fact that science was (and still is) one of the three core subjects.

An important test for the professional bodies will be to produce, or in some way make possible, a unified curriculum that makes sense in primary schools, mindful of the fact that many primary teachers have no science qualification beyond GCSE. Needless to say, the primary curriculum needs to transition as seamlessly as possible into the secondary.

## Science beyond and across the 'big three'

The three main sciences are disciplines in their own right, but there are important scientific disciplines that are not covered in any of these three. Burlington House in London, home of the Royal Society of Chemistry, is also home to the Geological Society and the Royal Astronomical Society. Many aspects of geology and astronomy lie outside the three major sciences and might escape attention. And these are far from the only sciences in this position: psychology is one of the top five most popular A-level subjects, yet its profile is very low pre-16.

It has always been hard to find a home for earth sciences in the National Curriculum in England. Part of the problem is that many science teachers have not themselves studied earth sciences at university or at school. The 1988 version of the National Curriculum made a brave attempt to integrate earth science, but it was never popular with the teachers, particularly the chemistry specialists who were often expected to teach it. Gradually, earth science was whittled away from the curriculum, and that is how it remains.

Another aspect of this issue is that modern science is highly interdisciplinary, and many of the most exciting and dynamic scientific developments happen at the interfaces between the traditional sciences: think of molecular biology, nanotechnology and modern materials science. The three professional bodies will need to agree, first, how to deal with established sciences, such as geology, that lie at least partly outside the big three. Secondly, they will need to agree how to deal with emerging fields such as nanotechnology, and indeed to find ways to show pupils that science flourishes at the interfaces and is not confined to three big silos.

### *Assessment*

'What gets assessed is what gets taught' is the reality in many English schools, so it will be essential for the professional bodies to work together to ensure that the assessment arrangements are at least as robust as the curricula they accompany, especially when it comes to GCSE and A-level. This is both an individual responsibility for each professional body, and also a collective responsibility when it comes to assessment arrangements for any combined science qualifications.

A key stakeholder here is of course the English exams regulator Ofqual. The more that Ofqual can be persuaded that science standards at GCSE and A-level are in safe hands with the professional bodies, the better the curricula will fare.

### *A route to technical qualifications*

A long-standing weakness of the English education system has been the confusion, and sometimes lack of quality, around our technical qualifications. A new system of technical qualifications, called T levels, will start to be taught from 2020, and will be aligned with existing apprenticeship structures. It is important for the professional bodies to ensure that any new science curricula provide a suitable preparation for these technical routes as well as for the longer-established academic routes.

## What next?

I know that the professional bodies continue to refine their three discipline-focused curricula, including the critical stage of consulting their professional members and a wide range of teachers. This consultation process will give the curricula a robust authority that a regulator or awarding body could never achieve on its own. In addition, priority should be given to dealing with the issues of common ground that I have described above. I think it is particularly important to turn attention to some of the common issues around assessment, and to decide how far to take the question of a common approach.

A final word: experience of developing science curricula, especially the National Curriculum, Salters' and Nuffield programmes, teaches me the iron rule that science curricula are always too full of content. Let us hope these new curricula are distinguished not only by their authoritative, modern content, but also by parsimony. That means cutting until it feels too sparse and then cutting some more.

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