Framing the secondary science curriculum

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Reviews of the curriculum, and the science curriculum in particular, have become a regular feature of the educational landscape in the UK. As I write (in August 2018), Wales is in the throes of its own review, while in England the first cohorts of pupils to follow the new GCSE specifications are awaiting their results. There is no agreed timetable for the next set of reviews, but they will undoubtedly happen at some stage.

In some senses this is just as it should be. Science changes, the needs of pupils and of society change, and our understanding of how pupils learn changes. In response, science education is itself continuously developing. But while the exercise of change may be necessary, the process is often flawed. Too often, revisions are rushed and there is not enough time for reflection, discussion and consultation. In an ideal world, there would be time to reflect on where we are now, to learn from research, to gather insights from practice in other countries, and above all to have the discussions and consultation between teachers and other stakeholders that are too often conspicuous only by their absence.

That, in essence, is the purpose of this themed edition of *School Science Review*: to begin a wider conversation about the secondary science curriculum in the UK, with the long-term aim of developing a coherent and well-argued vision that the science and science education communities can support with enthusiasm and conviction.

The work of the professional bodies

The themed articles in this edition are based around the work of three of the UK's main professional bodies for science: the Royal Society of Biology (RSB), the Royal Society of Chemistry (RSC) and the Institute of Physics (IOP). They have been working for some time to develop their visions for the curriculum in their respective disciplines and to that end they have established committees to develop curriculum frameworks, drawing on consultation with their members, including teachers, education researchers and professional scientists.

The work of these committees received its first public airing at a seminar run by the Salters' Institute in February 2018. At the seminar, the professional bodies presented their frameworks together for the first time, marking the beginning of a wider conversation about the future of the secondary science curriculum. You can find a short summary of the seminar proceedings at www.saltersinstitute.co.uk/news/framing-secondary-science-curriculum-next.

Presentations of the work of the societies form the core of this edition of *School Science Review*. A short introductory article, co-authored by the chairs of their committees, sets out their aims and ways of working. To varying degrees, they have set their work in the context of school education as a whole, from ages 5 to 19, although the focus of the articles in this edition is on ages 11 to 16.

All the societies have taken a high-level view. Their aim at this stage is not to propose a curriculum as such but rather to develop overarching frameworks to guide governments, awarding bodies and others in their thinking and planning of science curricula in general. All include reference to what are variously called 'big ideas' or 'big questions', which provide both a rationale for content choices and guidance for progression through the curriculum. While their approaches are different, the aim is that in due course they will cohere to provide a consistent framework for science curricula to guide future thinking.

A response from Sir John Holman, President-Elect of the Association for Science Education (ASE), welcomes the work of the professional bodies but also highlights some of the knotty issues that will need to be addressed in the future. How can we develop common approaches that respect the differences that exist between the disciplines but still promote science as a coherent whole? What are the implications for primary science, and for science teaching post-16? And what about the important areas of science that lie outside the core disciplines (such as earth science) or between them (such as molecular biology)?

Setting the context

Alongside the articles from the professional bodies are three articles that set the context and introduce some wider issues. Michael Reiss notes that 2018 is the 20th anniversary of the publication of *Beyond 2000*: *Science Education for the Future* (Millar and Osborne, 1998). This influential report by Robin Millar and Jonathan Osborne made the case for seeing the science curriculum primarily as a course to enhance general 'scientific literacy', and in so doing set the agenda for the next phase of developments in the science curriculum. Michael

observes that the latest curriculum changes have meant that the wheel has turned full circle, with the very concept of balanced science for all now in question. Echoing the ten recommendations of the *Beyond 2000* report, he raises ten challenging questions for the future.

One benefit of allowing more time for development is that it gives the opportunity to learn from the experience of other countries. Jonathan Osborne was professor of science education at King's College London but moved to Stanford University in 2009. He gives a thoughtful and well-informed account of the development of the Next Generation Science Standards (NGSS) in the USA. There is much to learn from the US experience, not least the sophisticated model of scientific activity that underpins the framework. His exposition of the idea of 'scientific practices' finds strong echoes in the IOP's article, which argues for using the idea as one of three fundamental dimensions of physics curricula. The prominence in the US standards given to earth sciences should also give UK science educators pause for thought.

Phil Ramsden's article gives a thought-provoking account of the development of balanced science, from the late 19th century to the present. He reminds us that, as recently as the 1980s, 10% of boys and nearly 20% of girls did no science at all in years 10 and 11 (ages 14–16), while only one in ten girls studied physics. The National Curriculum and the introduction of GCSEs have changed all that, but his article warns us that nothing can be taken for granted, and that gains made can be lost. He also reminds us that science teachers have themselves been divided on the issue (and no doubt still are), so that debate and discussion within the community is vital if progress is to be made. As a past chair of ASE, it is not surprising that he also highlights the crucial role played by the Association in these debates.

Involvement of teachers

Four years ago, Andrew Hunt edited a themed edition of *School Science Review* on 'Perspectives on the science curriculum' (Hunt, 2014). In his introduction, he said that he was encouraged by the response from the wide range of people he had asked to contribute, but regretted that none of the five teachers and a head teacher who had originally agreed to contribute was able to do so. He included an extended quote from one of these teachers. It is worth repeating a part of that quote:

> *I would love to write an article about how teachers and departments should try to see curriculum change as a positive thing, and an opportunity for innovation and refreshment. However, this would seem a little hypocritical given the frustrations that all teachers experience with the relentless march of change in the science curriculum.*
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> *In my career so far, I cannot remember a year that the teachers in my department were not writing and resourcing one or more schemes of work, across the suite of science subjects and the key stages that we teach. An incredible amount of effort goes into this process, and the relentless meddling by politicians in the science curriculum does little to inspire the next generation of scientists and scientifically literate citizens. Thankfully good-quality teaching does.*

This sentiment was strongly echoed at the Salters' Institute seminar, where a delegate's plea for the importance of the support and involvement of teachers won the loudest applause of the evening. The prospect that the science, industry and education communities could unite around a common vision of the curriculum is compelling, not least because it would provide a strong bulwark against the kind of political meddling that Andrew Hunt's teacher complained of. The professional bodies have made it clear that the involvement of teachers is at the heart of their process and their decision to publish their initial reports in the ASE's own journal is a clear mark of their intentions.

That thought leads to the final article in this edition, from Marianne Cutler, Director of Curriculum Innovation at the ASE. She explains how the ASE is working in partnership with the professional bodies to develop their frameworks. The particular role of the ASE is to promote the engagement of the science teaching community and she sets out various ways in which ASE members and others can get involved.

Conclusion

The aim of the professional bodies, working with the ASE and others, is to develop guidance for well-thought-out and coherent curricula that the science and science education communities can support with conviction and enthusiasm. The vision is to develop curricula that will endure because they are based on clear principles and an understanding of best practice, and because they carry the support of all the key stakeholders and above all of science teachers. Our hope is that this edition of *School Science Review* will mark the beginning of that process.

References

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