'Framing the Secondary Science Curriculum – Where Next?'

The Royal Society of Biology (RSB), The Royal Society of Chemistry (RSC) and the Institute of Physics (IoP) present their vision for the future of the curriculum in the sciences.

On 27 February 2018, as part of its Centenary celebrations, the Salters' Institute hosted a seminar at Salters' Hall, London, where key stakeholders in science education in England and Wales discussed the future of the curriculum in the sciences.

The Institute of Physics, the Royal Society of Chemistry and the Royal Society of Biology have been working to define their visions for the curriculum in their respective disciplines. These frameworks are being developed through consultation with their members, communities, teachers and professional scientists. At the seminar the learned societies presented their frameworks for the first time, marking the beginning of a wider conversation about the future of the secondary science curriculum.

A View from the USA – The Next Generation Science Standards

The seminar was introduced by Anthony Tomei, the Institute's director. He noted that the national curriculum had only recently been reviewed. The review had been done in a hurry, had been disruptive and was only just bedding in. There was no appetite for further reform at present. However, there would undoubtedly be a further review at some stage and the learned societies had wisely decided to use the present period of calm to prepare for the future; to take a considered and comprehensive approach and to establish a shared view for the curriculum in the sciences. He explained that the work of the learned societies was at a high level – focusing on frameworks and core curriculum topics, rather than defining detailed specifications.

One advantage of a longer timetable was that it allowed time to learn from other countries. The seminar next heard from Professor Jonathan Osborne, Kamalachari Professor of Science Education, Stanford University, who spoke about the development of the Next Generation Science Standards (NGSS) in the United States. Professor Osborne, who was involved in authoring the new standards, explained how the NGSS doesn't just focus on content knowledge, but combines this with eight scientific practices and seven 'crosscutting concepts', explicitly focusing on performance expectations (.e.g. constructing scientific explanations, or using arguments based on evidence) as outcomes of learning. He also described how the process of developing the standards had been carried out. The

committees had involved a number of high level scientists and Professor Osborne reflected on the positives and negatives of this.

Science Education in the UK – The Future: Introduction and Overview

Introducing the presentations from the learned societies Professor Sir John Holman, Chairman of the Salters' Institute & President of The Royal Society of Chemistry, explained why he felt the seminar was so important. Highlighting the increasingly important role science plays in the lives of every person, he emphasised the need to develop our curriculum to meet the needs of both future citizens and scientists.

Professor Holman also spoke about the strengths of our current science education system compared with many other countries. Schools on the whole have well-equipped labs; the national curriculum means there is continuity; there is balance across the three main sciences; and the teaching of the sciences is done in parallel, not in sequence as in some other countries. He welcomed the involvement of the learned societies in shaping the curriculum.

Presentations from the learned societies

Charles Tracy, Head of Education at the Institute of Physics, presented their vision for the future physics curriculum. The framework focuses on the 'big ideas' of physics - the take-away, important concepts that might be thought of as the high level destinations of an education in physics to age 16. These ideas are structured into three 'dimensions': how physics is practised; the content of the subject; and applications of physics.

Charles highlighted some of the challenges in presenting the entire physics curriculum in this framework, including the difference in importance and magnitude of 'big ideas', and the number of 'big ideas' that need to be included.

From the Royal Society of Chemistry, Helen Harden, a member of the RSC's 11–16 curriculum working group, presented their framework for the chemistry curriculum.

In a similar structure to the IoP's 'dimensions', the RSC propose three curriculum 'Components': Chemistry as a science; Chemical concepts; and Chemistry and the world. Within the Components, the working group have developed 'big questions' as a framework for the curriculum. They wanted to create explanatory stories as opposed to focus on 'facts', and having questions echoes the investigative nature of the scientific approach. Sticking to the core questions of the subject also helps to future-proof the curriculum. The framework features questions such as '*What are things made of?*', '*How do we do chemistry?*', and '*What is the impact of chemistry?*' The content of the curriculum serves to answer these questions in increasing depth over time.

Professor Libby John, Chair of the Curriculum Committee for the Royal Society of Biology, presented their curriculum framework for biology, focusing on ages 11–16. The aim of this framework is to ensure that the curriculum at all stages and routes is as relevant as possible to students. She highlighted that the biology curriculum serves a very broad purpose – biology has many students who go on to pursue a huge variety of careers. In planning their framework, they have made a particular effort to improve progression and consistency by mapping content in key themes across the 5–19 range. As for the RSC, the themes are grouped into big questions, which form the framework of the curriculum.

Response and discussion

Professor Michael Reiss, Professor at University College London and Master of the Salters' Company, gave a response to the presentations from the learned societies. He welcomed their involvement in thinking about the future of the curriculum. He noted that there was considerable similarity in their approaches, which bodes well for the ultimate aim of developing a single coherent science curriculum. He argued that discussions of the content must include topic areas that lie outside or across biology, chemistry and physics. For example, how is earth science to be included, and should we say anything about human behaviour? The societies confirmed that they will be considering these broader questions in shared discussions in the future.

In conclusion, Professor Sir John Holman hosted an open discussion on the frameworks with a panel of the representatives from the academic societies.

The discussion raised the question of whether or not it is possible to have a single curriculum that serves the needs both of citizens and of future scientists. The panel was unanimous in its view that there should be only one route through science education up until age 16. Professor Holman noted that the science curriculum also needs to prepare students for technical routes beyond age 16 and the frameworks must serve that need too.

The panel was asked if the societies had considered the extent of content in their frameworks with respect to allowing students time to embed learning. Professor Holman agreed that we must be careful not to put in too much content into the frameworks. Helen Harden said that having a strong curriculum framework would help, as it supports the structuring of content for students.

The panel was in agreement with a comment from the floor that to convince government of these frameworks they must show how they address the needs of employers. Nicole Morgan of the RSC said that the consultation process for the frameworks will include consulting with employers and indeed that they have already been involved in shaping the frameworks. Employers have highlighted that they want students with the skills that are addressed in the 'practices' components of the frameworks.

There was again strong agreement with a comment from a delegate who noted that it is essential to win the support of teachers when consulting on the frameworks, otherwise teachers will feel as though these are yet more reforms that are being forced upon them. The representatives from the learned societies assured the audience that consultation with teachers had high priority.

Professor Holman concluded the discussion by noting that the societies had independently converged on very similar models for the curriculum in their respective subjects. He encouraged the societies to analyse the work that would need to be done to put these frameworks into practice, should they be accepted for a new science curriculum. He gave the societies a number of questions to reflect on, including the position of earth sciences and other sciences outside the three core disciplines, how these frameworks will support technical routes, and how curricula based on the frameworks should be assessed.

Next steps

More detailed descriptions of the learned societies' curriculum visions, along with articles by Professor Jonathan Osborne, Professor Michael Reiss and other authors will appear in a special themed edition of the Association for Science Education's (ASE's) School Science Review, to be published in the autumn.