The new National Curriculum for England

Flying out of danger

"Crisis in science education avoided…" is hardly a front-page headline, but this is exactly what occurred with the National Curriculum in 2010. The revised National Curriculum for England is implemented in schools from this coming September. The version prior to this, a new secondary curriculum, was introduced in 2007. It is this 2007 version which represented a serious threat to science education, and addressing its limitations was a key part of the 2010 review.

Tim Oates
(Chair, Expert Panel on the National Curriculum Review)

When the National Curriculum was introduced, following the 1988 Education Reform Act, it was detailed and long. When unveiled by Education Minister Kenneth Baker in 1989, Margaret Thatcher was reputed to have said, "I did not intend it to be this big". Duncan Graham, first chief executive of the National Curriculum Council, details in his autobiography the difficulties in controlling the scope and content of individual subjects, attributing this particularly to the ceding of design responsibilities to subject working groups. Each group, he argued, faced with the task of drawing up a national curriculum for the first time, was anxious to represent all elements and perspectives present in their subject area. The overload required attention, and Sir Ron Dearing's 1994 review undertook a well-aimed refinement of the content. It preserved the conceptual richness and depth of the original specifications, but radically reduced complexity and prescription. The industrial action which accompanied the first National Curriculum and its assessment arrangements subsided. Subject working groups, such as the mathematics group chaired by Margaret Brown, strove hard to drive evidence-based reduction and reorganization of content. A further refinement in 1999 gave a National Curriculum with rich conceptual content in science.

1995 Science – Key Stage 3
Materials and properties

Chemical Reactions

i. that when chemical reactions take place, mass is conserved;
j. that virtually all materials, including those in living systems, are made through chemical reactions;
k. to represent chemical reactions by word equations;
l. that there are different types of reaction, including oxidation and thermal decomposition;
m. that useful products can be made from chemical reactions, including the production of metals from metal oxides;
n. about chemical reactions, *e.g. corrosion of iron, spoiling of food*, that are generally not useful;
o. that energy transfers that accompany chemical reactions, including the burning of fuels, can be controlled and used;
p. about possible effects of burning fossil fuels on the environment.

The conceptual depth of the 1995 curriculum was retained, and indeed elaborated in the 1999 specification:

f. to represent compounds by formulae and to summarize reactions by word equations;
g. how mass is conserved when chemical reactions take place because the same atoms are present, although combined in different ways.

This depth and conceptually richness is consistent with the notion of 'entitlement' to essential knowledge, understanding and skills which was embedded in the 1998 Act. This entitlement, of **all** pupils to **all** elements of key subjects, is a key principle which underpins the very existence of the National Curriculum.

The statement "to represent compounds by formulae and to summarize reactions by word equations" represents archetypically the 'power' of scientific understanding expressed in Michael Young's 'powerful knowledge' thesis[1]; it gives young people the ability to represent chemical structure in an abstract way, through formal notation, and facilitate both accurate description of deeper structures, and manipulate chemical

Abbreviations: KS3, Key Stage 3; QCA, Qualifications and Curriculum Authority

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compounds. It is what the Enlightenment gave us, and provides us the powerful technology which surrounds us and on which we depend. But this well-evidenced conceptual richness was severely compromised by the subsequent review in 2005. Consider the first statement in the 1995 specification: “i. that when chemical reactions take place, mass is conserved”. Secure understanding of this and other key conservations are fundamental to understanding of energy, chemical reactions and more[2,3]. Without sound understanding of conservation of mass, young people around the age of 11–15 years are unlikely to progress in key areas of physics and chemistry[4,5]. The absence of secure understanding of this concept will be an impediment to effective learning of extensive areas of science for which it is an essential foundation[4]. Its importance is underlined by Shayer’s related work on decay, over a 30-year period, of children’s understanding of the fundamental conservations[6].

The 2005 review version was launched with events which strongly emphasized the erosion of subject boundaries, which were seen as “traditional boxes”. In comparison with the 1999 curriculum, the reduction in the content was considerable:

2005-07 – Chemical and Material Behaviour

In their study of science, the following should be covered:

a. Chemical change takes place by the rearrangement of atoms in substances;
b. There are patterns in the chemical reactions between substances;
c. New materials are made from natural resources by chemical reactions;
d. The properties of a material determine its uses.

In this revised specification, explicit reference to conservation of mass, oxidation etc. was no longer present. The **legal requirement** to ensure that children understood these essential elements was lifted from the system. Statements such as point b, “There are patterns in the reactions between substances”, are highly generic, and do not ensure that key concepts such as conservation of mass are acquired at the right time in education, or by all pupils. This subverts the original purposes of the National Curriculum for England.

On the release of the revised specifications I sought clarification from the Qualifications and Curriculum Authority (QCA) on the intended impact of these generic specifications. The response was interesting in terms of use of the different instruments which had been developed by QCA. The response stated that, “although the programmes of study have changed, the (far more detailed) schemes of work will remain the same”. This is problematic on two important counts. First, the key claim that the National Curriculum had been slimmed and school autonomy opened up was open to question. Secondly, the Schemes of Work were not a statutory requirement, and therefore not a formal requirement of schools. The QCA’s position represented a serious policy confusion regarding instruments and aims. By failing to use the statutory instruments for a principled statement of key conceptual content, the 2007 specifications represented a serious threat to science education at Key Stage 3 (KS3).

The official perspective on this was described in ministerial remit letters and in the Select Committee’s retrospective historical overview (UK Parliament 2009)[7]:

In 2005, the Department asked the QCA to review the secondary curriculum at Key Stage 3. This was with the principal aim of further reducing the amount of prescribed content in order to give teachers more time and space to support personalized learning – broadly understood as the tailoring of what is taught and how it is taught to the needs of the individual pupil. Key Stage 4 was later included in the remit of the review. The new secondary curriculum places greater emphasis on pupils’ understanding of the concepts, ideas and processes of subjects, on cross-curricular themes and on pupils’ development of life skills. It became statutory from September 2008.

The changes in the 2007 specifications in science were led in part by a rationale which sought to add more elements to the curriculum as a whole: ‘functional skills’, cross-curriculum elements such as ‘enterprise’ and ‘technology and the media’; and ‘personal, learning and thinking skills’, and to add them in such a way that the curriculum did not swell to pre-1995 levels. The political problems which this original overload had caused were still present in the minds of bureaucrats. This had the undesirable effect of placing conceptual richness in subjects at odds with the new and expansive content.

This was a toxic mix of priorities. The reduction in the size of the science specifications, from 121 to 37 at KS3, was effected through this move to highly generic statements. Although limited to KS3 and KS4, there was a high risk that this would be used as a blueprint for reform of the entire National Curriculum. Significantly, the direction of development in the 2007 revisions contrasts strongly with a range of jurisdictions which both have introduced national curricula and have improved rapidly in both equity and outcomes[8].

Singapore provides an interesting contrast to English developments. Concerned that schooling should be extending pupils' learning into outcomes such as learning strategies and personal and civic development, the Singapore Ministry of Education (MOE) added responsibilities to teachers and schools through carefully managed piloting and professional development. It was theorized and implemented as an addition to the conceptual richness of subject-specific teaching, not as substitution. As described below, in Singapore, detailed state-approved textbooks and teaching practice continued to emphasize deep understanding in key concepts and operations in subjects. The emphasis on 'wider skills' was 'as well as' not 'instead of'.

Over three decades ago, the English system developed a series of high-quality textbooks linked to well-designed assessments through projects such as Nuffield Science and School Mathematics Project (SMP). England has moved away from 'linked elements' such as these just as high performing systems have embraced them. In Singapore, the National Curriculum statements are indeed relatively generic in character[9]. But simply to compare the 'top level' documents of England and Singapore is highly misleading. This is because, in addition to the legal statement of its National Curriculum, Singapore possesses state-approved textbooks, which give highly detailed specification of expectations and a clear outline of progression in key conceptual elements of science and maths. These heavily condition the enacted curriculum, and ensure entitlement to understanding of key constructs. Singapore's improvement is impressive since it has attained both high standards and high equity during the Primary phase[10] despite relatively high socio-economic inequality[11]. Interestingly, it has also secured high enjoyment in mathematics[12].

Schools are not required to use textbooks but if they do, then they must use the state-approved texts, and they are almost universally used. The textbooks can be seen as a more detailed analogue of the QCA non-statutory schemes of work but, as state-approved instruments, are far more potent in conditioning the curriculum and providing curriculum entitlement[9].

In pointing out the role of state-approved textbooks in conditioning the enacted curriculum, I am not advocating the immediate adoption of state-approved textbooks in science education in England. Rather, I am highlighting the risks in moving from conceptually rich statements of legal requirement (e.g. the 1999 version) to conceptually weak statements in the National Curriculum (2007) in the absence of other policy instruments which require schools to ensure students' access to, and mastery of, that rich content. Without other statutory instruments which possess well-evidenced conceptual content, arranged in well-ordered learning progressions, the National Curriculum has to include content which meets these requirements. But the 1995 and 1999 specifications were not perfect. Little detailed transnational comparison was done when they were developed, and research on curriculum coherence and learning progressions has improved significantly since 1999. Rather than simply returning to 1999, the 2010 review, undertook a wide-ranging systematic analysis of the content of national curricula from high-performing jurisdictions, and scrutinized the evidence on the form of national curricula and their supporting instruments, such as teacher training, approved textbooks and so on. From this evidence, vital principles for the review included a focus on "fewer things in greater depth", "a focus on key concepts, principles, fundamental operations and core knowledge" and a distinction between the National Curriculum (the State's well-evidenced listing of key content) and the School Curriculum (rich and expansive learning experiences designed to give all pupils access to this content, and more).

The 2010 Review, and the new National Curriculum about to be implemented did, in my view, avert a serious crisis, and ensures that the content essential to high attainment, high equity and high enjoyment in science education, at all ages, is placed at the heart of our education arrangements in England. ■

Tim Oates was Director of Research at the National Council for Vocational Qualifications and became Head of Research at the Qualifications and Curriculum Authority on its formation in 1997. In 2006, he joined Cambridge Assessment, a non-teaching department of Cambridge University, as Group Director of Assessment Research and Development. From December 2010 to August 2012 he was seconded to the Department for Education to offer policy advice and research intelligence and to chair the Expert Panel on the National Curriculum Review. He is a visiting Professor at University of Leeds Department of Education and a Fellow of Churchill College Cambridge.

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