Stabilising the curriculum to allow true innovation

The following summary is based on sections 4.1 to 4.5 of the Royal Society's *Vision for science and mathematics education* report, published 26 June 2014.

Summary

1 In its report published on 26 June 2014, The Royal Society sets out its Vision for science and mathematics education for the next 20 years.

2 A central recommendation is that science and mathematics curricula, and the accompanying assessment and accountability arrangements, should be stabilised so they change over longer time-scales than political cycles. (See pages 65 – 72 of the report).

3 Since the Government introduced the National Curriculum in 1989, there have been at least ten major reforms to the curriculum and national assessment in England.

4 Frequent changes in curriculum and assessment absorb the time and energy of teachers that could usefully be spent preparing more inspiring lessons or on professional development to improve subject knowledge and teaching skills encouraging innovation.

5 This instability is not in line with other countries with successful education systems, which change their curricula and assessment much less frequently than England. The aim should be to ensure a dynamic and high-quality curriculum that evolves over time but does not require frequent radical change.

6 The proposals begin with the sciences and mathematics, which are the particular concern of the Royal Society, and which comprise two out of the three core subjects in the National Curriculum in England. However, these proposals could be extended to include other subjects.

7 It is proposed that the expertise of the science, technology, engineering and mathematics (STEM) professional bodies should, under a strong overarching body, be used to stabilise the curriculum and assessment, providing a platform for excellent science and mathematics teaching.

8 At the subject level, the long-term development of the content and assessment of A-levels in the three core sciences (biology, chemistry and physics) should be entrusted to the Society of Biology (SB), the Royal Society of Chemistry (RSC) and the Institute of Physics (IoP). There is no single professional body for mathematics, but the Council for Mathematical Sciences is a good starting point.

9 Each of these bodies counts academics, teachers and employers among its members and has a long history of expertise in its subject. The IoP, RSC and Institute of Mathematics and its Applications already validate university degree courses in their subjects, so they know about regulating the content and standards of qualifications and are trusted by universities and employers.

10 The professional bodies would convene subject committees to address the curriculum for A-levels across the sciences and mathematics. In time, the principle could be applied to the curriculum and assessment for science subjects and mathematics at all levels and include vocational qualifications.

11 The professional bodies would convene a standing subject committee for each of the major sciences (physics, chemistry, biology and computer science) and mathematics, with representation from universities, employers, schools and colleges. This would build on the subject committees already established in 2013 by the IoP, RSC and SB.

12 Examination boards would be required to consult with the subject committees during the development of their specifications, and to submit the draft specification for their approval before final submission to Ofqual.

13 Having established the subject criteria and approved specifications, the subject committees would continue in existence indefinitely, to review the application of the criteria and ensure that they remain up to date. The members of each committee would have a defined term of office.

14 They would monitor the content and standards of live A-level examinations in their subject, and alert examination boards and Ofqual to any concerns about the quality and standard of examinations in any particular specification.

15 Each subject committee would draw on research evidence, and commission new research, if needed, to enable it to take a long-term view. At any time, it would have a considered position on the current state of the evolution of the qualification(s) it is reviewing, and the next phase of their development. This would end the current stop–start evolution of the curriculum and qualifications. There would be an agreement that the curriculum and assessment would change no more frequently than, say, once every five years.

16 There have been positive reports of the work that has already been started by the A Level Content Advisory Board (ALCAB). This work could be an excellent starting point from which to bring these proposals to life.

17 At a general level, there should be an overarching curriculum and assessment body responsible for setting out broad criteria to ensure fundamental equity and consistency of standards between subjects, and coherence across the curriculum. This body would work alongside, but would not replace, the qualifications regulator Ofqual.

18 This overarching body would be independent and established with cross-party agreement. It would comprise a small number of senior people with strong credibility representing employers, academics and teachers. It would have a strong chair of great personal standing and would draw on authoritative evidence in making its recommendations, as would each of the subject committees.

19 Given the need for cross-party agreement, these arrangements would need time to be put in place. We suggest mid – 2017 as the date by which the arrangements would be in place for A levels. At this point, the subject committees would begin their monitoring role, but given that A level is due to change in 2015, there would be no further changes until 2020. Extension of the arrangements to GCSE and other Key Stages would happen once the arrangements were established, say from 2019 onwards.

20 An independent group, with international membership, could be established to monitor and evaluate the workings of all the new arrangements in the first few years.

21 The attached briefing paper, drafted in February 2014 for the Vision Committee, gives further detail on the proposal. It includes detail of the changes to the curriculum in England since 1989, and draws some international comparisons.

Stabilising the curriculum to allow true innovation

This briefing paper was drafted by Sir John Holman on behalf of the Royal Society's Vision for Science and Mathematics Education Committee (date of final draft February 2014).

It was written to inform the Royal Society's Vision for Science and Mathematics Education report and debated at a roundtable meeting on 21 November 2013. For membership of the Vision Committee and a list of those who contributed to the roundtable, please see Annex 3.

Many people have told us we need to 'take the politics out of education'. We do not agree. UK state education consumes over £80 billion[i] a year of taxpayers' money, and it is right that policy should be determined by ministers whom taxpayers have elected.

But there is one aspect of education where frequent change causes special difficulties for teachers, and inhibits the kind of innovation which can lead to better teaching. This aspect is the curriculum and assessment, which are the foundations on which teaching is based. Since the Government of England and Wales[ii] introduced the National Curriculum in 1988, there have been at least 10 legislative changes to the curriculum and national assessment in England[iii]. Annex 1 has details of the changes and an outline of the impact they have had on teachers. It is not only changes in the curriculum that affect the environment within which Science and Mathematics are taught. Changes to the associated assessment, to the accountability framework (Ofsted and performance tables) and to centrally driven national strategies for teaching, all need to be accommodated to by teachers in the classroom.

Adjusting to changes absorbs time and energy that teachers could otherwise use to prepare better, more inspiring Science and Mathematics lessons. When the curriculum and exam syllabuses change, teachers have to adopt new teaching schemes, buy new textbooks and take professional development time that could otherwise be used to improve teaching and encourage innovation. We accept that some evolutionary change to the curriculum is always going to be necessary, if only to keep up with changes in subject content, but we think change needs to be less frequent and more measured.

We are not criticising the revised Science and Mathematics curricula that are being implemented by the coalition Government, but we do want to propose processes that will result in less frequent future changes.

What might be done to stabilise the curriculum?

Might it be possible to create an independent organisation to determine curriculum and assessment policy in a measured way, giving stability over a longer timescale than the political cycle? There are examples from elsewhere of technical decisions being taken by independent expert bodies: for example in scientific research (the Haldane Principle), in health (NICE) and in monetary policy (the independent Bank of England and the Monetary Policy Committee). But none of these analogies is perfect, and none could be directly translated to the curriculum. We have looked at other administrations with successful education systems to see whether there is a model that could be directly adopted in England (Annex 2), and we have concluded that there is not. Where a country's curriculum is stable, it is not usually because of a particular organisational structure, but for cultural and historical reasons that do not exist in England.

There have been attempts to introduce independent advisory bodies in England in the past, with mixed results. The most recent was the Qualifications and Curriculum Development Agency, QCDA, which was

abolished in 2011 when its functions were absorbed into the Department for Education. Even before that, QCDA and its predecessors[iv] had a sometimes unhappy relationship with Government, perhaps because of Ministers' fear that they had been captured by the educational establishment.

We have consulted experts and looked at examples from other areas of public policy in England, and we conclude that to work effectively, a truly independent curriculum body would need to meet the following conditions.

- Be demonstrably independent, with a strong chair.
- Draw on authoritative evidence, as does NICE in health and the MPC in monetary policy.
- Be rooted in respected and established civic institutions.
- Reflect the interests of employers, academics and teachers, and draw on their expertise.
- Provide advice on the curriculum, its assessment and the accountability framework within which they operate. All three interact together and it is not possible to consider the curriculum in isolation from the other two.

An independent curriculum body

We do not believe that any existing or imaginable body would meet these conditions on its own. QCDA and its predecessors did not, and in particular did not draw on the kind of research evidence that we argue is essential for education policymaking, nor were they rooted in established institutions. However, such institutions do exist at the subject level in the Sciences: they are the professional bodies, the Institute of Physics (IoP), the Royal Society of Chemistry (RSC) and the Society of Biology (SB). These bodies are each in a strong position to define and defend the content and standard of their subject: each has academics, teachers and employers among their members and each has a long history of expertise in its subject – far longer than the lifetime of any of the curriculum advisory bodies that have come and gone over the past 25 years. The IoP and the RSC already validate university degree courses in their subjects, so they know about regulating the content and standards of qualifications and they have the trust of universities and employers.

Our proposal is to use the expertise of the professional bodies, under a strong overarching body, as the cornerstone of arrangements to stabilise the curriculum and assessment.

How this would work at A level

Our proposed approach is best illustrated by reference to A levels, but in time it could be applied to the curriculum and assessment for Mathematics and Science at all levels.

In England, the DfE already started down the road towards independence for A levels when, in 2012 the Secretary of State stated his wish for control of A levels to be passed to universities[v]. This intention was welcomed, though it has proved hard to implement in practice. Control of A levels is now fragmented across the Russell Group, the DfE and Ofqual, with the exam boards playing a critical part. We believe an opportunity has been missed by failing to give the professional bodies the key role in the development of A level Sciences and Mathematics, and that this opportunity should be revisited.

Our proposals here are limited to Science and Mathematics: these subjects are our particular concern, and they comprise two out of the three core subjects in the National Curriculum. However, the proposals could be extended to include other subjects.

In essence, we propose

1 **At the subject level**, the long term development of the content and assessment of A level in the three Sciences should be entrusted to the IoP, RSC and SB. In the case of Mathematics, there is no single professional body, but the Council for Mathematical Sciences (CMS) would be a good starting point. The professional bodies would each convene a standing subject committee for the major Sciences (Physics, Chemistry and Biology) and Mathematics, with representation from universities, employers, schools and colleges. These committees would build on the work that has already been started by the A Level Content Advisory Board (ALCAB).

2 **At the general level**, there should be an overarching curriculum and assessment body responsible for setting out broad criteria to ensure fundamentals of equity and consistency of standards between subjects, and coherence across the curriculum. This body would work alongside, but would not replace, the exams regulator Ofqual, which would continue to secure consistent standards between examination boards.

Each subject committee would draw on research evidence, and commission new research if needed, to take a long term view so that at any time it would have a considered position on the current state of evolution of A level in the subject and what needed to be done next. This would remove the 'stop-start' experience that currently prevails in the evolution of the curriculum and qualifications. There would be an agreement that the curriculum and assessment would change no more frequently than, say, once every five years[vi]. Subject committees would consult extensively within the subject community, and develop detailed criteria, specifying core content and assessment requirements. Exam boards would be required to consult with the subject committee during the development of their specifications, and to submit the draft specification for approval before final submission to Ofqual.

Having established the subject criteria and approved specifications, the subject committees would continue in existence indefinitely, to review the application of the criteria and ensure that they remain up to date over time. They would continually monitor the content and standards of live A level examinations in their subject, and alert exam boards and Ofqual to concerns about the quality and standard of examinations.

Extending to GCSE and Key Stages 1 - 3

Once a trusted methodology had been established at A level, it could be extended lower down the age range, to GCSE and eventually primary.

The subject committees in Physics, Chemistry, Biology and Mathematics would be in a position to come to a view on the content of A level and GCSE at separate subject level. However, when it came to the core Science curriculum at Key Stage 4 and below, an approach that was consistent across all Sciences would be essential. It would therefore be necessary for the major subject communities across the Sciences to come together (perhaps through SCORE) to produce a Science curriculum for GCSE that was consistent with that at post-16. Eventually, the remit of the Science and Mathematics subject committees would be extended across all Key Stages. These arrangements would have the advantage of securing curriculum continuity across the entire age range from 5 to 18.

Some questions and answers about our proposals

Q1 *In what way would these arrangements be different from what happens already?*
At present, the curriculum is controlled by the Standards and Testing Agency, an executive agency of the DfE. The agency does not have (nor pretends to have) expertise at the subject level, so it convenes panels of subject advisers, often drawn from the professional bodies as we are proposing here, but in an *ad hoc* way. Under our proposals, the overarching body and the subject committees would be independent of DfE and closer to the subject communities, with a remit to change the curriculum no more frequently than every 5 years.

Q2 *How would these proposals succeed in stabilising the curriculum where this has not been achieved before?*
Cross-party agreement would be sought for the new arrangements, and in particular to the requirement that the curriculum and assessment would change no more frequently than once every five years.

Q3 *Why would the overarching body be more independent and successful than its defunct predecessors (QCDA etc.)?*
Cross-party agreement would be sought to create an overarching body with the following characteristics:

- Chaired by a person of great personal authority.
- A small high-quality committee made up of senior people with strong credibility among political parties.
- Appointments to be agreed by Opposition as well as Government and confirmed by the Education Select Committee.
- Long term appointments, perhaps 7 years, or in an era of 5 year fixed term parliaments, 5 year appointments made mid-parliament, e.g. May 2017.

Q4 *How would the overarching body and subject committees relate to Ofqual?*
Ofqual has established itself as an effective regulator and we would not wish to replace it. Its role would continue to be to secure consistent standards over time between subjects and between exam boards.

Q5 *Would Government be able to intervene if things went wrong?*
Government would be able to overturn the recommendations of the overarching body and ultimately to dismiss it, but this would need to be by cross-party agreement and confirmed by the Select Committee.

Q6 *Why would the professional bodies want to take on this onerous role?*
The professional bodies are the custodians of their subjects and are committed to securing appropriate content and standards. Two of them (RSC and IoP) are already trusted by universities to do the same job at degree level. All three professional bodies have established subject committees which could be readily adapted to meet our proposed remit. The professional bodies are in a better position than anyone else to draw on relevant research evidence relating to the curriculum and assessment in their subject, and to commission new research where needed. There might need to be some financial agreement to perform the new function, but the cost would be small relative to the total fees charged by the exam boards each year.

Q7 *What about subjects other than Science and Mathematics?*
Our proposals are deliberately confined to Science and Mathematics, but could be extended to other subjects, perhaps using Science and Mathematics as a pilot. Strong professional bodies exist in some subjects (eg Geography) but not in others, so in some cases it would be necessary to convene special committees for the purpose. There is a precedent for this in the accreditation of university degrees, where special committees are convened if a strong professional body such as RSC or IoP is not in a position to take it on.

Q8 *What would be the timescale for these proposals?*
Given the need for cross-party agreement, these arrangements would need time to put in place. We suggest mid – 2017 as the date by which the arrangements would be in place for A levels. At this point, the subject committees would begin their monitoring role, but given that A level is due to change in 2015, there would be no further changes until 2020. Extension of the arrangements to GCSE and other Key Stages would happen once the arrangements were established, say from 2019 onwards. An independent group, with international membership, would be established to monitor and evaluate the workings of all the new arrangements in the first few years.

Annex 1: A summary of changes to the curriculum and assessment framework for Science and Mathematics in England and Wales since 1988.

The first part of this annex gives a timeline for changes affecting the teaching of Science and Mathematics since 1988. The second part outlines the impact of these changes on teachers.

1.1 Changes to the curriculum, assessment and accountability for Science and Mathematics

Legislation	Change
Education Reform Act 1988	First announcement of statutory National Curriculum.
Education (Schools) Act 1992	Establishment of the inspectorate Ofsted.
Education Act 1993	Establishment of the School Curriculum and Assessment Authority.
Education Act 1996	Revision of the National Curriculum and changes to SEN assessment.
Education Act 1997	Establishment of the Qualifications and Curriculum Authority (QCA) and introduction of statutory baseline assessment at primary schools.
Education Act 2002	Revision of National Curriculum to contain Foundation Stage, with possibility of temporary school autonomy from the National Curriculum.
Education Act 2005	Revamped Ofsted inspections.
Education and Inspections Act 2006	Revision of National Curriculum (Science) with more school autonomy in taught curriculum.
Education and Skills Act 2008	Announcement of compulsory education or training to age 18 (implementation 2015).
Education Act 2011	Abolishment of QCA among other non-departmental public bodies.

Table 1: examples of legislative changes to curriculum and/or assessment arrangements in England 1988-2014

It is not only changes in the curriculum that affect the environment within which Science and Mathematics are taught. Changes to the associated assessment, to the accountability framework (Ofsted and performance tables) and to centrally driven national strategies for teaching, all need to be accommodated to by teachers in the classroom.

A teacher who began their career in 1988 will now be in their late forties. In this time, they have lived through the following changes introduced by Government.

1988 **Curriculum:** the National Curriculum first established through the 1988 Education Reform Act (ERA), legislated under Margaret Thatcher's Government. The National Curriculum was to cover 10 subjects in all: core subjects of English, Mathematics and Science and 7 foundation subjects.

The new Science Curriculum divided curriculum content in Biology, Chemistry and Physics (though not with those titles).

Assessment: The new ERA also introduced a universal assessment scheme, based on Attainment Targets. The attainment targets referred to a ten-point scale, designed to assess progression in each subject, with achievement labelled as Levels. For example, it was expected an average five year old was at Level 1 and the most able 16 year old could reach Level 10.

Problems with Attainment Target 1 and Attainment Target 17, among other things, resulted in rapid revision of the National Curriculum, leading to a reduction in the number of Attainment Targets from 17 to five.

1989 **Curriculum:** following the announcement in 1988, statutory National Curriculum was implemented on a phased basis from September.

Vocational: Government began work to create a new single system of vocational qualifications (GNVQ for educational qualifications and NVQ for qualifications gained through work).

1990 **Assessment:** the Department of Education and Skills accepted a standard national system of assessment, as recommended by the Task Group on Assessment and Testing (TGAT) report[vii]. This was designed to be formative as well as summative, covering all subjects with a single scale (of 10 levels for measuring pupil progress. Teacher led assessment was also to play an important part.

1991 **Curriculum:** the Mathematics curriculum was revised to an order with five attainment targets[viii].

Assessment: following Government's announcement of the National Curriculum assessment arrangements in 1990 (otherwise known as SATs[ix]), SATs were implemented for 7 year olds (end of Key Stage 1) in core subjects including Mathematics and Science.

The School Examinations and Assessment Council also set a cap for the maximum amount of coursework students could undertake in their GCSEs[x].

1992 **Curriculum:** Teachers began teaching new GCSE syllabuses (Key Stage 4) to reflect the National Curriculum 'Programmes of Study'.

Assessment: SATs were implemented for 14 year olds (end of Key Stage 3) in Mathematics and Science.

Accountability: Ofsted established as a non-ministerial Government department[xi] for England under Education (Schools) Act 1992[xii], bringing in the existing system of rigorous judgments on school performance.

Government also published the first secondary school performance tables (of GCSE results) in England[xiii].

1993 **Curriculum:** Government created the School Curriculum and Assessment Authority (SCAA) under the Education Act 1993[xiv], unifying the National Curriculum Council (NCC) and the School Examination and Assessment Council (SEAC)[xv].

Assessment: Teachers boycotted the national tests leading the Education Secretary John Patten to announce a full scale review of the National Curriculum and its assessment arrangements

Vocational: General National Vocational Qualifications, GNVQs, were piloted and launched across England. This expanded the access to vocational qualifications for schools (before only colleges had access to BTEC for example).

1994 Curriculum: Government commissioned review of the National Curriculum taken forward by Ron Dearing[xvi]. After a consultative process involving the teacher unions, Sir Ron's proposed a middle way for a revised National Curriculum to have:

- reduced prescription;
- reduced volume of material required to be taught;
- simpler programmes of study, with the aim of releasing an average of 20% of time for schools to use at their discretion;
- and more room within the curriculum at Key Stage 4 for 14-16 year olds to pursue academic and vocational options.

In addition, Dearing succeeded in persuading Government to guarantee the National Curriculum would not change for at least five years, which teachers welcomed.

Assessment: Sir Ron also advised for statutory testing to be confined to the core subjects, and to significantly cut back the number of attainment targets and supporting statements of attainments. As a result, the 10-level scale was shortened to an 8-level scale - with an additional category for exceptional performance.

In 1994, students sat the first GCSEs which reflected the National Curriculum Key Stage 4[xvii].

1995 Assessment: the first SATs after the Dearing Review were sat at all Key Stages in Mathematics.

For Science, assessment was simplified following the Dearing review with Attainment Targets in Science reduced from five to four. Supporting attainment level statements co existed with programme of study, which seemed suited to developing teaching programmes.

1996 Curriculum: a revised National Curriculum[xviii] was made statutory through the Education Act 1996 to reflect the recommendations made in the Dearing Review.

This included the revision of Mathematics curriculum, in which a large amount of the detail was removed.

Assessment: the Education Act 1996 also changed assessment arrangements for students with Special Education Needs (SEN)[xix].

Accountability: Government published the first performance table for primary schools[xx], intended to enable parents to compare across schools results from end of Key Stage 2 tests in core subjects including Mathematics and Science.

Government piloted projects in numeracy and literacy, setting out detailed teaching approaches.

1997 Curriculum: The Qualifications and Curriculum Authority (QCA) was set up through the Education Act 1997[xxi], this combined the previous National Council for Vocational Qualifications and the SCAA.

Assessment: optional National Curriculum tests for 8, 9 and 10 year-olds were first piloted to help track progress against target levels for Year 6 SATs (Key Stage 2)[xxii].

Accountability: through the White Paper *Excellence in Schools*, Government announced primary schools targets of one hour spent each on Mathematics.

1998 **Accountability:** all state schools expected to publish targets as well as exam performance in school prospectuses.

1999 **Curriculum:** following pilots in 1996, the new Labour Government introduced the National Numeracy Strategy as well as the Literacy Strategy. These had a profound effect on the way teachers were expected to teach.

Political devolution of the England and Wales also increased diversity of the taught curricula and assessment in UK, with power over education outside England in the UK devolving to the National Assembly for Wales. (Power over education was already devolved to the Scottish Parliament and the Northern Ireland Assembly.)

2000 Government implemented a range of qualification reforms (dubbed Curriculum 2000), picking up Lord Dearing's recommendations from1996 and their 1997 Manifesto commitments

Curriculum: a revised National Curriculum was introduced with further reduction of detailed curriculum content in most subjects including Science.

New A level courses came into force, where the two year AS level was replaced by the first year of an A level (renamed the A2). The new AS level would have the same breadth as an A level but half of its depth. These changes were aimed to encourage higher take-up and a broader curriculum at age 16.

As part of the revised National Curriculum, further revision of the Mathematics curriculum was implemented in 2000[xxiii] where the revised version[xxiv] provided more specificity. This revision involved wider and deeper consultations than any other.

Assessment: 'World class tests' were to be introduced to stretch the brightest A level students along with new key skills qualifications, which were designed to guarantee minimum standards in areas fundamental to employment eg application number, information technology and problem solving.

Vocational: Part 1 GNVQs were introduced to motivate 14-16 year olds.

Accountability: The QCA produced 'Schemes of Work' for Key Stage 1-3, which gave teachers topic guides giving examples for how teachers could cover the curriculum. However, due to the worries of Ofsted inspections and the accountability regime (school performance tables were by now fully embedded), the schemes of work were adopted in their entirety by the majority of schools despite being intended as guidance only. Teachers had limited scope to develop their own approaches as publishers increasingly sought the endorsement of Awarding Bodies for their textbooks.

2001 **Assessment:** Wales abolished tests for seven year old children.

Accountability: Wales abolished all school performance tables.

English Government introduced the Secondary National Strategy (2001-2011) for Science, alongside the Mathematics strategy which had developed from the numeracy strategy introduced in 1999. This laid down an expected teaching approach that was closely monitored by Ofsted.

2002 Curriculum: guidance on the Foundation Stage within the National Curriculum was made statutory through the Education Act 2002, which also enabled good schools to 'earn' autonomy from the National Curriculum[xxv] to have limited periods of experimentation.

Assessment: problems with grading the new A level system (there was confusion over assessment standards: 'reliability' and improving achievement) led to departure from office of Sir William Stubbs, QCA chair, and the resignation of Estelle Morris as Education Secretary of State.

Wales abandoned national tests at the end of Key Stage 1, though national tests in English/Welsh and Mathematics remained available for optional use by teachers.

2004 Curriculum: Government published report on post-14 Mathematics curriculum led by Professor Adrian Smith. The review, *Making Mathematics Count*, recommended a redesign of Mathematics curriculum and qualification to contain a two-tier system as well as an extension curriculum and assessment framework for more able pupils in Key Stage 3 and 4[xxvi].

Assessment: Government rejected most of the recommendations in the Tomlinson 14-19 Review, choosing a diploma for vocational courses but keeping existing 'gold standard' GCSE and A level exams.

The National Assembly for Wales began phasing out national tests for Key Stage 2 and 3.

Accountability: through the Education Act 2005[xxvii], Government reformed the Ofsted inspection regime to be more regular, lighter touch and to enable Ofsted to give shorter notices to schools about planned inspection.

2005 Assessment: SATs for seven year olds (Year 2, end of Key Stage 1) were still compulsory but when students were to sit them was flexible. Following a White Paper on primary education[xxviii], teachers were encouraged to use SATs test results to inform teachers of their pupils' progress rather than report them directly[xxix].

2006 Curriculum: following QCA review of the National Curriculum in 2005-6, major reform of the Science curriculum for 14-16 year olds was announced[xxx] with a revision of its Programme of Study and GCSE specification[xxxi]. This was a statutory reform[xxxii] of the National Curriculum in England for the final two years of compulsory Science schooling (Year 10-11).

- More variety of Science GCSE courses: in response to criticism that previous Science curricula (Key Stage 4) only focused on needs of future scientists rather than relating to students' everyday lives, QCA helped to bring about a wider variety of Science courses. These were designed to help teachers to match better the needs of their students. This included a Science course focusing on 'scientific literacy'[xxxiii], which were to be taken by most students with optional academic courses or applied courses in Science set within employment

settings. The compulsory amount of Science studied would make up at least one Science GCSE for each student.

- Less prescriptive content: the new Key Stage 4 Science curriculum was far less prescriptive about Science content than before, with content summarised in one page, and the component 'How Science works', which combines academic and practical skills, made compulsory. This component was criticised by Ofqual the exams regulator in 2009[xxxiv], and led to the introduction of Controlled Assessment for practical work.

For primary schools, Mathematics teachers were told by Education Secretary Alan Johnson to teach more mental arithmetic and enable children master multiplication tables by age eight.[xxxv] Primary curriculum guidance was also available from the National Strategies' document Framework for Mathematics[xxxvi].

Assessment: Schools minister Jim Knight announced GCSE exams in Mathematics to be made harder as part of Government drive to raise basic educational skills.

The reform also required a minimum quarter of the GCSE Science to be internally assessed (work-related reports, assessment of presentations, investigations etc), and a minimum of a quarter to be externally assessed. Exams did not have to be taken at the end of Year 11 but could also be taken at the end of year 10 or in stages throughout the course.

2007 **Assessment:** Education Secretary Ed Balls announced Science as an additional diploma, amongst new additions of languages and humanities to be introduced in 2008.

The National Assembly of Wales approved of changes to assessment for Key Stage 2 and 3, to be implemented by 2010.

2008 **Curriculum:** the revised curriculum from 2005/6 was implemented on a phased basis from 2008, containing more cross-curricular themes, skills and personalised learning.

Science curriculum: following the QCA 2005-6 secondary curriculum review, Government encouraged schools to provide Triple Science GCSEs to more able pupils (measured at Key Stage 3), while the Key Stage 3 Science curriculum was revised with reduced content to give schools greater flexibility in deciding what to teach.

Accountability: Ofqual created to secure standards of qualifications.

2009 **Assessment:** SATs for Key Stage 3 only were abolished for Mathematics and Science. Teachers could use instead QCA's optional Assessing Progress in Science and Assessing Pupils' Progress, which had guidelines helping teachers to identify progression relative to the levels of the curriculum.

Mathematics SATs test for 11 year olds continued.

Accountability: Ofsted in 2009 began 'snap visits' by inspectors with 48hrs notice, and made greater use of 'local intelligence'.

2010 **Curriculum:** Coalition Government rejected Sir Jim Rose's plans of Science for the Primary Science Curriculum[xxxvii]. The new Government's paper *The Importance of Teaching*, announced a review of the National Curriculum.

Assessment: Science SATs test scrapped for 11 year olds.

2011 **Curriculum:** Incoming Education Secretary Michael Gove scrapped the QCDA under the Education Act 2011 and Government formally announced overhaul of the curriculum[xxxviii].
At the same time, the White Paper *The Importance of Teaching* acknowledged the important role of professional associations and institutes in influencing the curriculum and qualifications.

2013 **Curriculum:** the National Curriculum was further reduced in its level of prescription[xxxix]. In anticipation of a new National Curriculum, as an interim measure Government told school teachers to still teach statutory subjects but that they no longer needed to follow programmes of study (and associated attainment targets and assessment arrangements for Key Stage 3) from September.

Accountability: Government announced plans to implement a new performance measure, the English Baccalaureate (EBacc), in 2014-2016 to replace the 5A*-C measure. The EBacc would show the top eight qualifications where pupils achieved a grade C or above at Key Stage 4 core subjects. The EBacc was designed as a measure of school performance for the audience of parents and pupils, and would be taken into account in Ofsted inspections[xl].

2014 **Accountability and assessment:** Government abandoned the EBacc in February[xli].

Curriculum: as part of the new National Curriculum following the 2011-2012 review, Government plans to implement a new National Curriculum from September for Mathematics and Science for Primary School (except Years 2 and 6) and Secondary School Key Stage 3 (Years 7-9)[xlii].

2015 **Curriculum:** as part of the new National Curriculum following the 2011-2012 review, Government plans to bring into force new Mathematics and Science curriculum for children in Years 2 and 6, who will be the last cohort to sit the old Key Stage 1 assessment and Key Stage 2 tests.

Nationwide teaching of the new Key Stage 4 curriculum and new GCSEs for Mathematics and Science is scheduled to begin September 2015.

2017 **Assessment:** All GCSE students are scheduled to sit GCSEs reflecting the new National Curriculum following the 2011-2012 review from 2017, with GCSE students in the academic years 2014/2015 being the last cohort to sit the old GCSEs.

1.2 How these changes affected teachers

Jim Ryder (Ryder & Banner 2011, 2013) has described the difficulty of achieving effective curriculum reform[xliii]. This is not a problem confined to England: there is evidence from international studies[xliv] of the difficulty of converting curriculum intentions into classroom realities.
In a study of the 2006 changes to the Key Stage 4 curriculum in England Ryder describes the challenges of successful planning and implementation[xlv].

These include:

- the long timescale involved in systemic educational reform (3-5 years);
- the multiple aims of school Science education;
- the diversity of school contexts;
- the need for coherence across multiple education reform policies;
- the diverse professional goals and identities of teachers.

The evidence from these studies is that curriculum change needs to be carefully planned and prepared for, as was the case with the new Hong Kong curriculum implemented from 2012 and considered to be an example of successfully managed curriculum change (OECD, 2010)[xlvi].

Ryder shows the challenge of a *single* curriculum change. But as the evidence in the first part of this annex shows, there have been many changes. Not all of these are as radical as the 2006 reforms, but even relatively small changes to assessment models, such as moving from modular assessment to linear assessment[xlvii], or to the accountability framework, such as the suggested introduction of the English Baccalaureate, have an impact on Science and Mathematics teachers' work.

The direct impacts on classroom teachers may include the need to:

- Plan new schemes of work
- Learn and prepare for new schemes of assessment
- Attend training programmes, often arranged by exam boards, to introduce new assessment arrangements
- Work with technicians to introduce and try out new practical activities
- Select and buy new textbooks
- Prepare new day-to-day classroom resources and activities
- Adapt these new activities to match differing student groups
- Work with colleagues to trial new activities and adapt as appropriate over time as expertise is gained.

Not all this activity is counter-productive: for example, introducing new practical activities can be a good thing. One teacher in Ryder's study said the reform gave his department 'an opportunity to really think about what we were doing...there was a real genuine attempt by us all to try and put together a really exciting scheme of work'.

But when change is almost continuous, as it has been since 1988, teachers have little time to consolidate on what works best before they have to prepare for the next change. And because they are spending their time responding to external change, they have little time to reflect in a professional way on what works best in their teaching, nor to attend continuing professional development to keep their subject knowledge and teaching skills up to date. One teacher in the third year of the 2006 reformed curriculum said: 'I don't feel like even now into the third year of it. I don't even feel that it's really settled down yet. We're slowly getting to grips with it.'

Annex 2: International comparisons

The following is a short research study that we carried out to look at overseas models for control of the curriculum and assessment. [What follows is the research report from Lina Munro and John Holman, dated 21.10.13]

Method

This paper will compare eight countries in their international exam performance (PISA) and compare who controls the curriculum and assessment. From a preliminary quick comparison of international frameworks of curriculum and assessment, the eight countries are:

1. Australia
2. Finland
3. France
4. Hong Kong
5. Republic of Ireland
6. Scotland
7. Singapore
8. USA

This paper first ranks the countries in their most recent international PISA performance (2009) in section 4.1. The remainder of section 4 features summaries of each country's curriculum and assessment framework. Section 5 presents an analysis of the results.

Results

2. 1. International PISA Performance

Country/economy	Mean mathematics score	Mean Science score
Singapore	573	551
Hong Kong - China	561	555
Finland	519	545
Republic of Ireland	501	522
Australia	504	521
United Kingdom	494	514
France	495	499
OECD average	494	501
United States	481	497

Table generated from PISA 2012 Results, EduGPS Explore Data, OECD 2014 to order competing countries/economies, ranking is based on the average score in mathematics, Science *and* reading.

2. 2. Australia

Who controls the curriculum and assessment?

ACARA (Australian Curriculum, Assessment and Reporting Authority) [xlviii]– since 2009

- **Role**: controls and implements the National Curriculum and national assessment, as well as managing national school reporting (first time all this is centralised).
- **Created by:** the Ministerial Council on Education, Early Childhood Development and Youth Affairs (MCEECDYA).
- **Funded by:** the states, territories and Australian Government.
- **Approved by:** the Standing Council for School Education and Early Childhood (SCSEEC)[xlix].

Further work: How independent is ACARA? [Requires stakeholder research]

2. 3. Finland

Background[l]: Finland used to have strong state control of improving education, with high level of inspection (inspectors at back of every classroom) and a very centralized (i.e. state controlled) National Curriculum. The Basic Education Act in 1983 began decentralization and teacher autonomy, with the curriculum reform in 1994 giving local authorities more freedom. The National Curriculum is no longer prescriptive but a guide, with just ten pages on Mathematics[li]. Schools now have a greater say in the curriculum.

Who controls the curriculum?

Finnish National Board of Education (FNBE) – since 2004

- **Role**: controls the national *core* curricula for pre-primary, 'basic' and 'general upper' secondary school, as well as vocational qualifications[lii].
- **Subordinate to:** the Ministry of Education and Culture.
- **Answers to:** the Finnish Government.

Who controls the assessment?

Matriculation Examination Board (MEB)[liii,liv]

- **Role:** administers national exam Year 12 students take (must pass to apply to university).
- **Appointed by:** the Ministry of Education and Culture.
- **Structure:** contains a secretariat of civil servants.

Further work:

- □ How independent are the FNBE and the MEB? [Requires stakeholder research]

2. 4. France

The Ministry defines the national curricula.

Further work:

- □ Is there a body linked to the Ministry who sets the national curricula and assessment in France?[lv]

2. 5. Hong Kong

Who controls the curriculum and assessment?

Curriculum Development Council (CDC)[lvi] – formerly the Curriculum Development Committee since 1972, renamed in 1999 after splitting into two tiers

- **Description:** a free-standing advisory body.
- **Role**: advises Government on curriculum - the Committee on Math last met in 2010 to review the Mathematics curricula and the Committee on Science recently met to review the secondary school Science curricula"[lvii].
- **Appointed by**: the Chief Executive of the HK Special Administrative Region (who is an elected politician, appointed by the Central People's Government) [lviii].
- **Two-tiered structure**: first tier is the CDC and its Standing Committee, second tier the Key Learning Area (KLA) Committees and Functional Committees. Each CDC Committee can form its own ad hoc committees for specific tasks.

Further work:

- How independent is the CDC? [Requires stakeholder research]
- Are there examples of CDC advising policy that the Chief Executive didn't take? [Requires stakeholder research]

2. 6. Republic of Ireland

Who controls the curriculum?

National Council for Curriculum and Assessment (NCCA)

- **Role**: advises the Minister for Education and Science on a primary and secondary curriculum.

School autonomy: "While Ireland has a centrally devised curriculum, there is a strong emphasis on school and classroom planning... selection of text books and classroom resources to support the implementation of the curriculum is made by schools, rather than by the Department of Education and Science or the National Council for Curriculum and Assessment." [lix]

Who controls the assessment?

State Examinations Commission (SEC) – since 1997

- **History:** took over from the Department of Education and Skills and the Inspectorate in 1997.
- **Described as**: a non-departmental public body supported by Government.
- **Role**: develops, assesses, accredits and certifies secondary examinations[lx].

Further work:

- How independent are the NCCA and the SEC? Why did it take over from the Dept of Education? [Requires stakeholder research]

2. 7. Scotland

Background: Curriculum for Excellence will be in force until 2016, when new qualifications developed by the Scottish Qualifications Authority (SQA) will be ready.

Who controls the curriculum? [lxi]

Currently implemented by 3 partners:

- Education Scotland
- SQA
- Scottish Government

Education Scotland

- **Description:** a Scottish Govt executive agency, operating "independently and impartially".
- **Accountable to:** Scottish Government.
- **Headed by:** a chief executive who is responsible to Scottish ministers for its performance[lxii].

SQA

- **Description:** "the national accreditation and awarding body in Scotland".
- **Sponsored by:** Scottish Government's Learning Directorate.
- **Headed by:** a Chair and Board, appointed by Government.

NB – the Scottish Government has appointed **an Advisory Council**, who provides *independent* advice to Ministers and SQA[lxiii].

Who controls assessment?

The Scottish Government does - through the Curriculum for Excellence.

Further work:

- How did SQA develop the new qualifications? How much say did Government have in them?
- How independent is the Advisory Council? Did it advise the SQA on the new qualifications? [Requires stakeholder research]

Singapore

Who controls the curriculum?

Ministry of Education (MoE): Curriculum Planning & Development Division (CPDD)[lxiv]

- **Role:** reviews the national syllabus and advises schools on curriculum.
- However, the Director of Training and Development Division of the MoE advised that schools have more autonomy[lxv].

Curriculum policy office (CPO)[lxvi]

- **Role:** advises on curriculum policy, informs it with research and help schools implement curriculum with partners e.g. the National Institute of Education[lxvii] and the Singapore Examinations and Assessment Board.

Who controls assessment?

Singapore Examinations and Assessment Board (SEAB)[lxviii] – since 2004

- **Background:** SEAB used to be the Examinations Division of the Ministry of Education.
- **Role**: develop and conduct national examinations.
- **Relationship to Government**: SEAB collaborates with MOE on all national examinations.

Further work:

- What is the relationship between the CPDD and the CPO? [Requires stakeholder research]
- Is the SEAB controlled by Government or does it have a degree of autonomy? If the latter, how independent is it? [Requires stakeholder research]

2. 8. USA

Who controls the curriculum and assessment?

- 50 states each make policy guidelines, local districts operate schools within the guidelines. In an effort to create a coherent National Curriculum, the National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO) sponsored a cross-state initiative called the Common Cores Initiative in 2009.
- This consults with almost everyone involved in education to find common values for guiding curricula. It is described as a "grassroots involvement of thousands" including "teachers, administrators, associations, parents, business, students, higher education faculty, Department of Elementary and Secondary Education staff, the Board of Education, and the public."[lxix]
- So far, 45 states, District of Columbia, four territories and the Department of Defense Education Activity have all signed up to the Common Core Initiative[lxx]. Local communities will use the frameworks to develop local curriculum, while the Department of Elementary and Secondary Education will base new assessment on the frameworks.

[i] UK Government Education and Training Statistics for the UK 2013, P21: https://www.gov.uk/Government/uploads/system/uploads/attachment_data/file/255083/v01-2013.pdf

[ii] In 1988, England and Wales had the same education system. This changed following devolution, and we are now talking about England alone.

[iii] Sargent et al, *INCA Comparative Tables: Table 4 – Recent Education Reforms*, March 2013. Contains public sector information, originally collated by the National Foundation for Educational Research (NFER) in England for the Department for Education and licensed under the Open Government Licence v1.0: http://www.nationalarchives.gov.uk/doc/open-Government-licence

[iv] Predecessors included the Schools Council, the National Curriculum Council, the School Examinations and Assessment Council, the School Curriculum and Assessment Authority and the Qualifications and Curriculum Authority.

[v] House of Commons Education Selection Committee First Report, *The administration and examination of 15-19 year olds in England:*
http://www.publications.parliament.uk/pa/cm201213/cmselect/cmeduc/141/14109.htm

[vi] There is a precedent for this in the curriculum review that was carried out by Lord (Ron) Dearing in 1994, with an agreement that there should be no more change for 5 years after the review. But this was a one-off.

[vii] National Curriculum, Task Group on Assessment and Testing, A Report, *Department of Education and Science and the Welsh Office:* http://www.educationengland.org.uk/documents/pdfs/1988-TGAT-report.pdf

[viii] National STEM Centre: http://stem.org.uk/rx4um

[ix] Colloquially known as Standard Assessment Tasks or Standard Attainment Tests, see Glossary, *Science and mathematics education, 5-14, A 'state of the nation' report,* the Royal Society 2010

[x] Politics.co.uk: http://www.politics.co.uk/reference/gcses

[xi] House of Commons:
http://www.publications.parliament.uk/pa/cm200607/cmselect/cmeduski/165/16504.htm

[xii] Legislation.gov.uk: http://www.legislation.gov.uk/ukpga/1992/38/introduction

[xiii] J. Reed & J. Hallgarten, *Time to Say Goodbye? The Future of School Performance Tables, Institute for Public Policy Research (IPPR), 2003, accessed via http://www.leeds.ac.uk/educol/documents/00003500.htm*

[xiv] Legislation.gov.uk: http://www.legislation.gov.uk/ukpga/1993/35/part/VI/crossheading/replacement-of-the-national-curriculum-council-and-the-school-examinations-and-assessment-council

[xv] Accessed via Oxford University Press, Oxford Index Beta version (2014): Susan Wallace, *A Dictionary of Education*, Oxford University Press 2009

[xvi] Dearing Review of the National Curriculum, 1994, SCAA:
http://www.educationengland.org.uk/documents/dearing/dearing1994.html

[xvii] Helen Patrick, *Comparing Public Examinations over Time,* University of Cambridge Local Examinations Syndicate, paper presented at BERA conference, September 1996:
http://www.leeds.ac.uk/educol/documents/000000061.htm

[xviii] House of Commons, Children, Schools and Families Committee, *National Curriculum Fourth Report of Session 2008–09, Volume I,* P12:
http://www.publications.parliament.uk/pa/cm200809/cmselect/cmchilsch/344/344i.pdf

[xix] http://www.legislation.gov.uk/ukpga/1996/56/part/IV/chapter/I/crossheading/identification-and-assessment-of-children-with-special-educational-needs

[xx] Gilliam Sherpherd MP, DfE:
http://www.education.gov.uk/schools/performance/archive/primary_96/psec1.shtml

[xxi] Legislation.gov.uk:
http://www.legislation.gov.uk/ukpga/1997/44/part/V/chapter/I?view=extent#text%3Dcurriculum%26extent%3D%3Dengland%2Bwales

[xxii] P15, Eurydice at NFER (2009):
http://www.nfer.ac.uk/shadomx/apps/fms/fmsdownload.cfm?file_uuid=67EAAF91-C29E-AD4D-07F1-A9373EA17105&siteName=nfer

[xxiii] Education Committee, Norfolk.gov.uk: http://www.committees.norfolk.gov.uk/Documents/education/14-07-1999/sc2000.pdf
[xxiv] DfE 1999: http://webarchive.nationalarchives.gov.uk/20130401151715/https://www.education.gov.uk/publications/eOrderingDownload/QCA-99-460.pdf
[xxv] Legislation.gov.uk: http://www.legislation.gov.uk/ukpga/2002/32/notes/division/2
[xxvi] Professor Adrian Smith, *Making Mathematics Count, an inquiry into post-14 Mathematics education: http://www.nationalnumeracy.org.uk/resources/57/index.html*
[xxvii]Legislation.gov.uk: http://www.legislation.gov.uk/ukpga/2005/18/notes/division/3
[xxviii] DfES, *Schools: Achieving Success*, http://collections.europarchive.org/tna/20040104233115/http://dfes.gov.uk/achievingsuccess/images/schoolsachievingwhitepaper.pdf
[xxix] Maughan, S. and Cooper, L. (2010). *'Policy and developments in Mathematics assessment in England', National Foundation for Education Research:* http://www.nfer.ac.uk/publications/44413/44413_home.cfm?publicationID=486&title=%20Policy%20and%20developments%20in%20Mathematics%20assessment%20in%20England
[xxx] QCA (2005), *Science: Changes to the curriculum from 2006 for Key Stage 4*: http://www.eriding.net/resources/Science/follow_up/subleaddevmeet/051025_mhodg_sci_ks4_qca-05-1645-sc-ks4-changes.pdf
[xxxi] Indira Banner (2011): http://tisme-scienceandmaths.org/wp-content/uploads/2011/02/EISER_School-Science-Review.pdf
[xxxii] Section 74 (6), Education and Inspection Act 2006: http://www.legislation.gov.uk/ukpga/2006/40/section/74
[xxxiii] a new GCSE Science piloted by QCA, ran by Awarding Body OCR and the Twenty First Century Science project (University of York Science Education Group and Nuffield Foundation)
[xxxiv] See Ofqual's review of Science GCSE 2007-2008: http://webarchive.nationalarchives.gov.uk/+/http://www.ofqual.gov.uk/files/ofqual-09-4148_GCSE_Science_2007_2008_report.pdf
[xxxv] the Guardian, 8 Sep 2006
[xxxvi]Department for Education and Skills, National Strategy for Primary, found in Gillard D (2011) *Education in England: a brief histor*y: http://www.educationengland.org.uk/documents/pdfs/2006-primary-national-strategy.pdf
[xxxvii] the Guardian, 7/6/10
[xxxviii] Nerys Roberts (2014), *National Curriculum Review*, SN 06798, Social Policy Section, House of Commons Library: http://www.parliament.uk/business/publications/research/briefing-papers/SN06798/national-curriculum-review
[xxxix]Department for Education: *consultation report: disapplication of aspects of the existing National Curriculum from September 2013:* https://www.gov.uk/Government/uploads/system/uploads/attachment_data/file/193837/CONSULTATION_REPORT__DISAPPLICATION_OF_ASPECTS_OF_THE_EXISTING_NATIONAL_CURRICULUM_FROM_SEPTEMBER_2013.pdf
[xl] DfE 2014, http://www.education.gov.uk/schools/teachingandlearning/qualifications/b00231686/english-baccalaureate-information-for-schools
[xli] BBC, 7/2/14: http://www.bbc.co.uk/news/uk-21363396
[xlii] DfE 2014, http://www.education.gov.uk/schools/teachingandlearning/curriculum/nationalcurriculum2014/
[xliii] Jim Ryder and Indira Banner (2011), *Multiple Aims in the Development of a Major Reform of the National Curriculum for Science in England*, International Journal of Science Education, 33:5, 709-725 http://dx.doi.org/10.1080/09500693.2010.485282

[xliv] (i) Eijkelhof, H. M. C. & Kapteijn, M. 2000. ANW: A *new course on public understanding of Science for senior general secondary education in the Netherlands.* In: Cross, R. T. & Fensham, P. J. (eds.) Science and the Citizen. Fitzroy, Victoria, Australia: Arena.
(ii) Kahle, J. B. 2007. Systemic reform: *Research, vision, and politics*. In: Abell, S. & Lederman, N. G. (eds.) *Handbook of research on Science education*. Mahwah, NJ: Erlbaum.
[xlv] Jim Ryder and Indira Banner (2013), *School Teachers' Experiences of Science Curriculum Reform*, Centre for Studies in Science and Mathematics Education, School of Education, University of Leeds http://www.tandfonline.com/doi/abs/10.1080/09500693.2012.665195?journalCode=tsed20
[xlvi] OECD 2010: Shanghai and Hong Kong: Two distinct examples of education reform in china http://www.oecd.org/countries/hongkongchina/46581016.pdf
[xlvii]AQA (2014), http://www.aqa.org.uk/news-and-policy/policy/changes-to-gcses/modular-to-linear
[xlviii] P15, http://www.oecd.org/education/school/48519807.pdf
[xlix] http://www.acara.edu.au/verve/_resources/ACARA_Governance_and_Advisory_Structure_-_2013.pdf
[l] http://curriculumredesign.org/wp-content/uploads/The-Finnish-National-Core-Curriculum_Vitikka-et-al.-2011.pdf
[li] http://www.ncee.org/programs-affiliates/center-on-international-education-benchmarking/top-performing-countries/finland-overview/finland-instructional-systems/
[lii] http://www.oph.fi/English
[liii] P17
http://www.sqa.org.uk/files_ccc/PNP_ResearchReport1_TheAssessmentSystemsFinlandQueensland.pdf
[liv] http://www.ylioppilastutkinto.fi/en/
[lv] More (French) information on http://www.education.gouv.fr/pid19/missions-et-organisation-du-ministere.html
[lvi] See organisation chart http://cd1.edb.hkedcity.net/cd/cdc/en/P02.htm
[lvii] http://cd1.edb.hkedcity.net/cd/cdc/download/cse/meeting/2013-2014/CDCC_SE_1stAgenda_2013_14_final.pdf
[lviii] http://www.gov.hk/en/about/govdirectory/govstructure.htm
[lix] http://www.ncca.ie/en/Curriculum_and_Assessment/
[lx] P22, OECD Review on Evaluation and Assessment Frameworks for Improving School Outcomes.
[lxi]http://www.educationscotland.gov.uk/thecurriculum/whatiscurriculumforexcellence/howwasthecurriculumdeveloped/index.asp
[lxii] http://www.educationscotland.gov.uk/about/remitandframework/role.asp
[lxiii] http://www.sqa.org.uk/sqa/5664.html
[lxiv] http://www.moe.gov.sg/about/org-structure/cpdd/
[lxv]See the report: www.vnseameo.org/downloads/malay/Singapore.doc.
[lxvi] http://www.moe.gov.sg/about/org-structure/cpo/
[lxvii] Trains teachers http://www.nie.edu.sg/about-nie/general-information/welcome-to-nie
[lxviii] http://www.seab.gov.sg/aboutUs/aboutSEAB.html
[lxix] http://www.doe.mass.edu/frameworks/
[lxx] http://www.corestandards.org/in-the-states

With thanks to:

- Richard Browne, Company Secretary, Mathematics in Education and Industry (MEI)
- Martin Hollins, independent consultant
- Professor Jim Ryder, School of Education, University of Leeds
- Helen Williams CB, formerly DfE

Annex Three

The Vision for Science and Mathematics Education Committee

- Sir Martin Taylor FRS (Chair)
  Warden of Merton College, University of Oxford
- Professor Dame Julia Higgins FRS FREng (Vice-Chair)
  Former Chair, Advisory Committee for Mathematics Education (ACME) and Senior Research Investigator, Department of Chemical Engineering, Imperial College London
- Professor Jim Al-Khalili OBE
  Professor of Physics, Professor of Public Engagement in Science, University of Surrey
- Mrs Linda-May Bingham
  Headteacher, Britannia Village Primary School, London
- Professor Sarah-Jayne Blakemore
  Royal Society University Research Fellow and Professor of Cognitive Neuroscience at University College London
- Professor Sally Brown OBE FRSE
  Convener on the RSE Education Committee, The Royal Society of Edinburgh
- The Rt Hon Charles Clarke
  Former Secretary of State for Education Oct 2002 – Dec 2004
- Professor Raymond Dolan FRS
  Director, Wellcome Trust Centre For Neuroimaging
- Professor Dame Athene Donald FRS
  Former Chair, Education Committee, The Royal Society and Professor of Experimental Physics, University of Cambridge
- Mr Michael Gernon (until December 2012)
  Principal, The RSA Academy. (Moved to Dubai in December 2012)
- Sir John Holman FRSC (from May 2012)
  Emeritus Professor of Chemistry, University of York and Senior Education Adviser, The Wellcome Trust and the Gatsby Charitable Foundation
- Sir Tim Hunt FRS
  Emeritus Principal Scientist, Cell Cycle Control Laboratory, Cancer Research UK London Research Institute
- Dr Ian Jones
  Royal Society Shuttleworth Education Research Fellow, Mathematics Education Centre, Loughborough University
- Dame Alison Peacock (from December 2012)
  Headteacher, The Wroxham School, Hertfordshire
- Professor David Phillips CBE FRSC
  Professor Emeritus and Former President, Royal Society of Chemistry
- Mrs Joan Sjovoll (deceased January 2013)
  Headteacher, Framwellgate School, Durham
- Mr David Swinscoe (from December 2012)
  Associate Director, STEM Partnerships, City & Islington College, London
- Professor Lord Winston Hon. FREng FMed Sci
  Professor of Science and Society and Emeritus Professor of Fertility Studies, Imperial College London
- Professor Alison Wolf CBE (from December 2012)
  Sir Roy Griffiths Professor of Public Sector Management, King's College London

Attendees at roundtable meeting on 21 November 2013

Nick Green, Head of Projects, Science Policy Centre, The Royal Society
Professor Jeremy Hodgen, Professor of Mathematics Education, King's College London
Dr Martin Hollins, Former Head of Science and Technology, QCA
Professor John Holman, Vision Committee member, The Royal Society
Professor Celia Hoyles, Professor of Mathematics Education, Institute of Education
Dr Hilary Leevers, Head of Education, The Wellcome Trust
Julian McCrae, Deputy Director, Institute of Government
Lina Munro, Project Assistant, Vision for Science and Mathematics Education
Malcolm Trobe, Deputy General Secretary, Association of School and College Leaders
Juliet Upton, Project Leader, Vision for Science and Mathematics Education