Some reflections on school science curriculum reform in England

Edgar Jenkins
Centre for Studies in Science and Mathematics Education, University of Leeds
More science is being taught to more students than at any time in history
More students are studying the separate sciences at GCSE level
The worse may be over in terms of falling A-level entries in physics and chemistry
• The overall performance of 15 year olds in England in PISA 2006 was better than most of the other 30 OECD countries, although less good than those in Finland, Canada, Japan, New Zealand, Australia and the Netherlands

• Student performance sensitive to the instrument used to measure it

• School performance standards in England vary considerably
Science teaching is supported by a very wide but uncoordinated range of STEM activities.

Ambassador schemes, taster courses, SET weeks, web-based activities, prizes, awards, competitions, podcasts, national and regional science centres, institutions of higher education, professional societies concerned with science and science education.
• Hands-on museums now part of a global industry to promote public understanding of, and engagement with, science

• Rapid growth in the coverage of science in the print and broadcast media

• Emphasis on inquiry-based approaches to teaching designed to enhance students’ interest in science and improve their learning

‘The future of Europe depends on a renewed pedagogy’ (European Commission 2007)
Students’ views of science are generally very positive, although more so in developing countries than in the industrialised world.
By focusing on ‘how science works, are we:

- ignoring important differences between the sciences?
- narrowing students’ perception of the many roles that the sciences play in the modern world?
- under-emphasising the role that creativity and imagination play in scientific investigation?
- missing an opportunity to indicate to students what is not yet known and why this is so?
Should we be satisfied with the way in which ‘How science works’ is being interpreted?

Is there a risk of science becoming an inadequate background against which students discuss issues that are essentially ethical, political or economic and where the underpinning science is difficult and complex?
If school science is being redefined, we need to recast the work of science teachers by equipping them to deal with issues characterised by controversy, uncertainty, ethical dilemmas, subjectivity
Many attempts to reform school science reflect:

- an assumption that the school science curriculum is overloaded with facts and this makes the sciences boring
- a belief that it is important to create a space within the curriculum for students to exercise independence and judgement, a space judged to be lacking in traditional science courses
• Narrow the gap between the best and worst levels of attainment
• Address issues of gender, ethnic and other imbalance
• Encourage more students from state schools to study physics in higher education
• Exploit ways in which modern electronic means of communication can enrich the science curriculum and transform students’ learning
• Make much more use of assessment for learning and encourage students to monitor their own progress
• Help students see ‘science’ as a creative and imaginative activity that plays many roles in the modern world
• Bring school science into closer contact with science-based activities in the wider community beyond school or college
• Raise the standards of science teaching to the highest possible level and remove any obstacles that prevent or hinder this
Choose the right people to become teachers
Develop them into effective teachers who teach consistently well
Establish systems and targeted support to ensure that every student is able to benefit from excellent teaching.

Secondary Science Curriculum: a Northern Ireland perspective

SCORE
Royal Society
Feb 2010

Dr Colette Murphy
School of Education
Queen’s University
Belfast
N. Ireland
I would like to acknowledge the expertise of all university and school colleagues who helped in the preparation of this talk, including:

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Mr Miguel Robinson
Mrs Pamela Thomlinson

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• Victoria College Belfast (science specialist school)
• Ballymena Academy
Overview: science in the NI curriculum

1. Introduction - secondary school science
2. NI Curriculum policy - 20 years of change
3. Science in the revised NI curriculum
4. Experiencing science in the revised curriculum: schools and initial teacher education
Traditional school science - a sense frame?

Science and everyday experience

The world of science

very few links

School science

some links

potential links

Science and other learning
Making sense of school science lessons

The world of science

LINKS - developed by policy-makers, curriculum developers and teachers

NI - 2/10

School science

NKS - developed by policy-makers, curriculum developers and teachers

NI - 5/10

Science and everyday experience

Science and other learning

NI - 5/10

LINKS - developed by policy-makers, curriculum developers and teachers
Science in the NI curriculum: pendulum swings…

• 20 years ago - most pupils studied science to 14

• Introduction of the NI common curriculum (1991) - compulsory science to 16

• Revised NI curriculum (2007) - science optional after 14
The “Big Picture” of the Curriculum at Key Stage 3

The Northern Ireland Curriculum aims to empower young people to achieve their potential and to make informed and responsible decisions throughout their lives.

**Curriculum Aim**
- to develop the young person as an individual
- to develop the young person as a contributor to society
- to develop the young person as a contributor to the economy & environment

**Learning for Life & Work**
- Personal Development
- Home Economics
- Local & Global Citizenship
- Employability

**Key Elements**
- Personal understanding
- Mutual understanding
- Personal health
- Moral character
- Spiritual awareness
- Citizenship
- Cultural understanding
- Media awareness
- Ethical awareness
- Employability
- Economic awareness
- Education for sustainable development

**Cross-Curricular Skills**

**Thinking Skills & Personal Capabilities**

**Areas of Learning**
- The Arts
- English
- Environment & Society
- Maths
- Modern Languages
- Physical Education
- Science & Technology
- Religious Education

**Promoting & Encouraging**
- Communication
- Using Mathematics
- Using ICT

**Learning Experiences**
- Investigating & problem solving
- Linked to other curriculum areas
- Relevant and enjoyable
- Media-rich
- Skills integrated
- Active and hands on
- Offers choice
- Challenging and engaging
- Supportive environment
- Culturally diverse
- Positive reinforcement
- Varied to suit learning style
- On-going reflection
- Enquiry based

**Assessment for Learning**
- Building a more open relationship between learner and teacher
- Clear learning intentions shared with pupils
- Shared / negotiated success criteria
- Individual target setting
- Taking risks for learning
- Advice on what to improve and how to improve it
- Peer and self assessment
- Celebrate success against agreed success criteria
- Peer and self evaluation of learning

**Attitudes & Dispositions**
- Personal responsibility
- Concern for others
- Commitment – determination – resourcefulness
- Openness to new ideas
- Self belief – optimism – pragmatism
- Curiosity
- Community spirit
- Flexibility
- Tolerance
- Integrity – moral courage
- Respect
Science in the revised NI curriculum at KS4

• Statutory requirements at KS4:
  – develop the cross curricular skills (Communication, Using Mathematics and Using ICT);
  – develop the other skills, defined as Problem-Solving, Self Management and Working with Others;
  – Learning for Life and Work;
  – PE; and
  – RE, based on the core syllabus specified by DE.
Areas of learning at Key Stage 4

### Areas of Learning

1. Language and Literacy
2. Mathematics and Numeracy
3. Modern Languages
4. The Arts
5. Environment and Society
6. Science and Technology
7. Learning for Life and Work
8. Physical Education

### Contributory Elements

- Employability
- Local and Global Citizenship
- Personal Development

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**GCSEs General Science**
- Applied science (double award)
- Science (double award)
- Science (single award)
- Science (entry level)

**GCSE Sciences**
- Biology
- Chemistry
- Physics

**GCSE Technology**
- Technology and design
- Technology and design (entry level)
Conclusion 8 – Need Greater Support for Primary Curriculum
• too many pupils develop negative attitudes to science and practical and investigative approaches are underdeveloped.
• the “World Around Us” has the potential to make science more relevant and exciting, but many primary teachers may lack the knowledge, skills and confidence to deliver an appropriate science and technology programme

Conclusion 9 – Need greater curricular coordination for STEM
• little joint planning between primary and postprimary schools in the STEM subjects, leading to repetition and insufficient emphasis on the relevance of STEM at a time which many consider to be critical in forming a child’s interest.

Conclusion 15 – Major decline in STEM subjects at A Level
• Physics, further mathematics and computer studies continue to decline at A-level.

Conclusion 18 – Narrow base of STEM schools offering A-levels
• 20% of the schools account for 70% of the entries - these are all selective schools.
# Experiencing revised curriculum science

<table>
<thead>
<tr>
<th>Positives</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential to make <strong>better links</strong> between school science, other subjects and the world outside school</td>
<td>Notably large gap in NI between highest and lowest achievers in science (PISA 2006)</td>
</tr>
<tr>
<td>Scope to relate school science more closely to <strong>student interests</strong>; student engagement and encouragement to choose science at KS4 becomes a priority</td>
<td>Legacy of prescriptive curriculum and choice for teachers to carry on ‘doing what they did before’</td>
</tr>
<tr>
<td>Pupils enjoy science more, according to evaluation sheets, participation and verbal feedback</td>
<td>New KS3 / KS4 transition issues, eg content-heavy and ‘difficult’ KS4 science</td>
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<tr>
<td>More time for less content; inclusion of <strong>more investigative, interesting and relevant science</strong></td>
<td>Temptation to start teaching KS4 science during KS3 to prepare students for GCSE</td>
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<tr>
<td>Teachers can decide <strong>HOW and WHY</strong> to teach particular KS3 topics; opens up professional dialogue</td>
<td>Lack of good courses at KS4 for those who cannot cope with the rigour of GCSE science</td>
</tr>
<tr>
<td>More scope for <strong>teacher choice</strong>; potential to reduce repetition of KS3 content at KS4</td>
<td>’Choice to ‘give up’ science after KS3</td>
</tr>
<tr>
<td>Removal of KS3 tests allows a <strong>more flexible approach</strong></td>
<td>Matching TSPC with science content</td>
</tr>
<tr>
<td><strong>Stronger links</strong> with primary schools and industry</td>
<td>Lip-service being paid to WALT, WILF, etc</td>
</tr>
<tr>
<td>Increased and more varied use of <strong>ICT</strong> in science lessons</td>
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Scotland’s new curriculum

Allyson Dobson
Team Leader (sciences) – Learning and Teaching Scotland
Professional Advisor – Scottish Government
Scotland's new curriculum

Relevant, inspiring, engaging education for every child and young person in Scotland

Experiences and outcomes

Guidance on how and what children and young people learn from the early years to the end of S3 is presented through experiences and outcomes.

Getting started with the experiences and outcomes.
Existing systems produce existing results. If something different is required the system must be changed.

Sir Christopher Ball; More Means Different (from a report on widening access to Higher Education)
Publication of draft experiences and outcomes
Consultation period and trialling
University of Glasgow report and subsequent action plan
Further development and consultation
New curriculum
What is the purpose of the new curriculum?

.... to develop the four capacities in children and young people.
<table>
<thead>
<tr>
<th>Values</th>
<th>The curriculum: all that we plan for children and young people’s learning</th>
<th>Effective teaching and active, sustained learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wisdom, justice, Compassion, integrity</td>
<td></td>
<td></td>
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</tbody>
</table>

| Experiences and outcomes | | |
|--------------------------|------------------|
| from early to fourth levels in 8 curriculum areas | Entitlements |

<table>
<thead>
<tr>
<th>Personal support</th>
<th>Principles</th>
<th>Alignment of</th>
</tr>
</thead>
<tbody>
<tr>
<td>for learning through choices and changes into positive and sustained destinations</td>
<td>Challenge and enjoyment Breadth Progression Depth Personalisation and choice Coherence Relevance</td>
<td>Assessment, qualifications Self-evaluation and Accountability, Professional development with purposes</td>
</tr>
</tbody>
</table>
How to locate GLOW paper

Es and Os

Sciences

All curriculum areas contribute to the totality of the experiences that make up the new curriculum. To find out more, read the curriculum overview.

Please note that within sciences, the experience and outcome codes that begin 'HWM' have been updated since publication on 7 April.

Principles and practice

Essential reading for practitioners as they begin, and then develop, their work with the statements of experiences and outcomes for the sciences.

Experiences and outcomes

Download all the experiences and outcomes for science:

- Word file: Sciences: Experiences and outcomes (470 KB)
- PDF file: Sciences: Experiences and outcomes (435 KB)

Explore the experiences and outcomes online

Read the introductory statements for sciences and browse quickly and easily to specific sets of experiences and outcomes.

You can also create and save your own personalised groups of outcomes for planning use.

Planet Earth
- Biodiversity and interdependence
- Energy sources and sustainability
- Processes of the planet
- Space

Biological systems
- Body systems and cells
- Inheritance

Forces, electricity and waves
- Electromagnetism
- Vibrations and waves
- Electric materials
- Properties and uses of substances
- Chemical changes

Glow Group

Glow Group

Link up with other practitioners around the country to share your ideas on Curriculum for Excellence.
Sci\'ences:
Concept development in the sciences

This material is for teachers to use alongside the experiences and outcomes as they plan for the development of learners' scientific knowledge, understanding and skills.

It describes progression in the development of knowledge and understanding of some of the scientific concepts which are contained within the experiences and outcomes as children and young people learn within a level and then move on to the next.

Line of development 01

The biodiversity and interdependence line of development (01) deals with survival of the species and adaptation to the environment. This is complemented by the inheritance line of development (14), which develops an understanding of how organisms develop and pass on genetic information to the next generation.

Evolution is introduced at the second level (SCN 2-01a), where learners relate the physical and behavioural characteristics of living things to their survival and extinction. They develop their understanding of the diversity of plants and animals by exploring a range of resources, including the local environment. They can explore simple adaptations which have taken place in plants and animals, such as features that allow flight and swimming, feeding mechanisms, and plant adaptations for drought or living on water. The concept of evolution can be introduced by studying the evidence of fossil records to develop an appreciation of organisms which have become extinct. Learners could study features which did not allow these organisms to survive in the changing environment e.g. flightless birds such as the dodo; and dinosaurs. Examples of living things under threat due to environmental changes can also be discussed.

The concepts of species diversity, distribution and adaptation for survival are further developed at third and fourth levels (SCN 3-01a and 4-01a).
<table>
<thead>
<tr>
<th>Level</th>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early</td>
<td>The pre-school years and P1, or later for some.</td>
</tr>
<tr>
<td>First</td>
<td>to the end of P4, but earlier or later for some.</td>
</tr>
<tr>
<td>Second</td>
<td>to the end of P7, but earlier or later for some.</td>
</tr>
<tr>
<td>Third and fourth</td>
<td>S1 to S3, but earlier for some. The fourth level broadly equates to SCQF level 4.</td>
</tr>
<tr>
<td>Senior phase</td>
<td>Beyond S3</td>
</tr>
</tbody>
</table>
Responsibility of all teachers to support the development of

- Literacy across learning
- Numeracy across learning
- Aspects of health and wellbeing
Effective interdisciplinary learning:

- can take the form of individual one-off projects or longer courses of study
- is planned around clear purposes
- is based upon experiences and outcomes drawn from different curriculum areas or subjects within them
- ensures progression in skills and in knowledge and understanding
- can provide opportunities for mixed-stage learning which is interest based.

The curriculum should include space for learning beyond subject boundaries, so that children and young people can make connections between different areas of learning.

Interdisciplinary studies, based upon groupings of experiences and outcomes from within and across curriculum areas, can provide relevant, challenging and enjoyable learning experiences and stimulating contexts to meet the varied needs of children and young people. Revisiting a concept or skill from different perspectives deepens understanding and can also make the curriculum more coherent and meaningful from the learner’s point of view.

Interdisciplinary studies can also take advantage of opportunities to work with partners who are able to offer and support enriched learning experiences and opportunities for children and young people’s wider involvement in society.
Building the curriculum 4
Skills for learning, skills for life and skills for work
Building the Curriculum 5 - A Framework for Assessment is the next step in providing support for staff as they implement Curriculum for Excellence. It provides an outline of the approaches to assessment to support the purposes of learning 3 to 18.

Published in 2010 by the Scottish Government, it sets out key messages about principles of assessment, standards and expectations, ensuring consistency, CPD and support, reporting to parents, informing self-evaluation for improvement and monitoring standards over time.

The information in this document, and expanded in this website, should be considered alongside assessment and achievement.

PDF File: Building the Curriculum 5: A framework for assessment (530 KB)
PDF File: Building the Curriculum 5: Executive summary (314 KB)
PDF File: Building the Curriculum 5: Quality assurance and moderation (295 KB)
PDF File: Assessment for Curriculum for Excellence: Frequently Asked Questions (83 KB)
“Henry! Our party’s total chaos! No one knows when to eat, where to stand, what to ... Oh, thank God! Here comes a border collie!”
How do you eat an elephant?

One bite at a time.
It is Important To Be Optimistic