Scientific Literacy in the UK
Status and Challenges

John Holman
National Science Learning Centre
University of York, UK
Come and see us at the National Science Learning Centre
Launch by Tony Blair, March 2006
Outline of my talk

- Some messages from PISA
- The importance of science education to a developed country
- Two policy challenges for scientific literacy – messages from *Twenty First Century Science*
- What matters most of all?
PISA 2006
Programme for International Student Assessment

- 30 countries from the Organisation for Economic Co-operation and Development (OECD)
- 27 partner countries
- 15 year olds
- 2006 study, results published December 2007
PISA 2006

Science
- UK performance is significantly above the OECD average
- 7 countries (including Japan) performed significantly higher than England
- 13 countries (including Germany) are not significantly different from England
- 36 countries (including France and USA) performed significantly worse than England
# PISA 2006

## Science is valuable for me

Percentage of students agreeing with positive statements about the personal value of science

<table>
<thead>
<tr>
<th>OECD average</th>
<th>UK</th>
<th>USA</th>
<th>Germany</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>64</td>
<td>72</td>
<td>54</td>
<td>55</td>
</tr>
</tbody>
</table>
PISA 2006
I would like a career in science
*percentage of students agreeing with statements about the value of a career in science*

<table>
<thead>
<tr>
<th>OECD average</th>
<th>UK</th>
<th>USA</th>
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</tr>
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<tbody>
<tr>
<td>29</td>
<td>25</td>
<td>36</td>
<td>26</td>
<td>21</td>
</tr>
</tbody>
</table>
**Horizontal axis:** Human Development Index
**Vertical axis:** Scores on questions designed to measure positive attitudes towards studying science

Svein Sjoberg, University of Oslo: Project ROSE
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Largest ever medical prize

The X PRIZE Foundation has announced a $10 million (£5.4 million) Archon X PRIZE for Genomics – A multi-million dollar incentive to create technology that can successfully map 100 human genomes in 10 days.
Our Nation's Future

Science will be as important to our economic future as stability

The Prime Minister to the Royal Society, Oxford November 2006
Public confidence in science

**GM Crops:** Success in US, failure in UK

**STEM Cell research:** Success in UK, failure in US

*Sir David King, UK Government Chief Scientist*
Public confidence in science

The alleged link between MMR (mumps, measles, rubella) vaccine and autism led to

• a drop in vaccination rate from 91% to 80%
• a rise in mumps cases from 119 in 1998 to 43,000 in 2005

Sir David King, UK Government Chief Scientist
We are all scientists now
(Sara Parkin, Forum for the Future)

It is essential to have young people prepared to become the engineers, research scientists and doctors of the future.

It is essential, but not enough. Developed countries also need a population who understand science, and are critically aware of its implications.
Two policy drivers in science education

- The need to provide an appropriate science curriculum for all students, and to lay the foundations for scientific literacy
- The need to provide a new generation of scientists and engineers

*In the UK, the lobby for the second of these is often more vociferous than the first*
Declining/static trend in A level entries for physics, chemistry and maths over the last 30 years

Entries shown as a proportion of the population aged 17 to take into account changes in the size of the cohort
What made you study Chemistry?

• Survey of 150 first year Chemistry and Biochemistry undergraduates at the University of York
How important was each of these in influencing you?
(1 = not important; 5 = very important)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Average, 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course and textbooks</td>
<td>3.46</td>
</tr>
<tr>
<td>Quality of school labs</td>
<td>3.33</td>
</tr>
<tr>
<td>Your chemistry teacher</td>
<td>4.18</td>
</tr>
<tr>
<td>Your parents</td>
<td>2.28</td>
</tr>
<tr>
<td>The job prospects</td>
<td>4.18</td>
</tr>
<tr>
<td>What your friends were choosing</td>
<td>1.36</td>
</tr>
<tr>
<td>Your exam grades at GCSE</td>
<td>3.35</td>
</tr>
<tr>
<td>Your exam grades at AS Level</td>
<td>3.78</td>
</tr>
</tbody>
</table>
Please add anything else that you think is important in influencing young people to study chemistry

Frequently mentioned in 2006 and 2007:

• ‘I just found the subject fascinating’
• ‘It’s a rigorous subject with high status’
• Hands-on, interesting practical work
• Enthusiastic teachers
• Seeing the relevance of chemistry to real life
• Spectacular, even dangerous experiments
UK NEEDS TO DOUBLE NEW SCIENCE GRADUATES OVER SEVEN YEARS OR SEE SKILLED JOBS DISAPPEAR

CBI Press Release, 12 March 2007
SET skills demands

Between 2004 and 2014 the net requirement for SET-related jobs will have increased to 2.4 million – a doubling of demand

*CBI March 2007*
Figure A15: Science Graduates (2003) per 100,000 persons in the employed, 25 to 34 years of age.

Source: OECD, Education at a Glance, 2005

Gross weekly earnings for STEM and non-STEM graduates, 2004

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• Two policy challenges for scientific literacy – messages from *Twenty First Century Science*
• What matters most of all?
Two policy challenges

- To provide a flexible curriculum to meet the needs of both the future citizen and the future specialist
- To achieve a consensus on what we mean by ‘a curriculum for scientific literacy’
A national curriculum for scientific literacy: present status in the UK

The principle of a curriculum for scientific literacy is established within the national curriculum, especially for 14 – 16 year olds (*Twenty First Century Science*)

The challenge is to ensure that the intended curriculum is matched by the curriculum actually implemented by teachers.
Twenty First Century Science
- a core science curriculum for 14 – 16 year olds that:

engages with contemporary scientific issues

covers the central Science Explanations*

develops key Ideas about Science*

* The two foundations of scientific literacy
Science Explanations

the big ideas of science
Science Explanations: some examples

SE2 Chemical change
SE3 Materials and their properties
SE4 Interdependence of living things
SE8 Gene theory of inheritance
SE11 Energy sources and use
SE12 Radiation
SE13 Radioactivity
SE16 The Universe
For scientific literacy …

Scientific knowledge is not enough …

You also need to have some understanding of science:

- as a form of knowledge
- as an approach to enquiry
Ideas about Science

Data and its limitations: **error and uncertainty**

Correlation and cause: **pattern seeking**

Developing explanations: **scientific explanations**

The Scientific Community: **peer review**

Risk: **real and perceived risks**

Making Decisions: **science and society**
Evaluation of *Twenty First Century Science* – some key messages (1)

- Teachers say it is harder to teach than a traditional course, but more worthwhile

- The evidence so far about students’ attainment in ‘Science Explanations’ (scientific content) and ‘Ideas about Science’ (scientific processes) is broadly neutral

- Teachers tend to emphasise ‘Science Explanations’ more than ‘Ideas about Science’ in their teaching, despite the fact that the course gives equal importance to both
Evaluation of *Twenty First Century Science* – some key messages (2)

- Students can see the relevance of science and the reasons for studying it
- Students’ appreciation of the importance of science **increases** after studying the course, but .....  
- ..... their interest in continuing to study science further **decreases** (though this happens with traditional courses too)
Policy conclusions from the evaluation of *Twenty First Century Science*

- A curriculum for scientific literacy can increase students' appreciation of the importance of science, and the reasons for studying it, but …..

- ….. it is unlikely on its own to make students more inclined to study science in the future.
A reflection on ‘Ideas about Science’

• It is more difficult to come to a consensus about a body of ‘Ideas about Science’ than about a body of ‘Science Explanations’. ‘Ideas about Science’ may be more socially and culturally dependent.

• Examples: most people would agree about the importance of understanding about scientific uncertainty, but what about Risk and ethical aspects of science?
Science elite rejects new GCSE as 'fit for the pub'

By Mark Henderson and Alexandra Blair

A NEW science GCSE that replaces traditional physics, chemistry and biology with discussions about topical issues such as GM crops and the MMR vaccine is attacked today by leading academics as “more suitable to the pub than the schoolroom”.
Two policy drivers in science education

- The need to provide an appropriate science curriculum for all students, laying the foundations for scientific literacy
- The need to provide a new generation of scientists and engineers

*In the UK, the lobby for the second of these is often more vociferous than the first*
Two policy challenges

- To provide a flexible curriculum to meet the needs of the future citizen and the future specialist
- To achieve a consensus on a curriculum for scientific literacy, in particular:
  - the balance between ‘Science Explanations’ and ‘Ideas about Science’
  - an agreed set of ‘Ideas about Science’
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How the world’s best-performing school systems come out on top

McKinsey, September 2007
How the world’s best-performing school systems come out on top

McKinsey, September 2007

Three things matter most

- Getting the right people to become teachers
- Developing them into effective instructors
- Ensuring the system is able to deliver the best possible instruction for every child
How the world’s best-performing school systems come out on top

McKinsey, September 2007

‘Above all, the top performing systems demonstrate that the quality of an education system depends ultimately on the quality of its teachers’