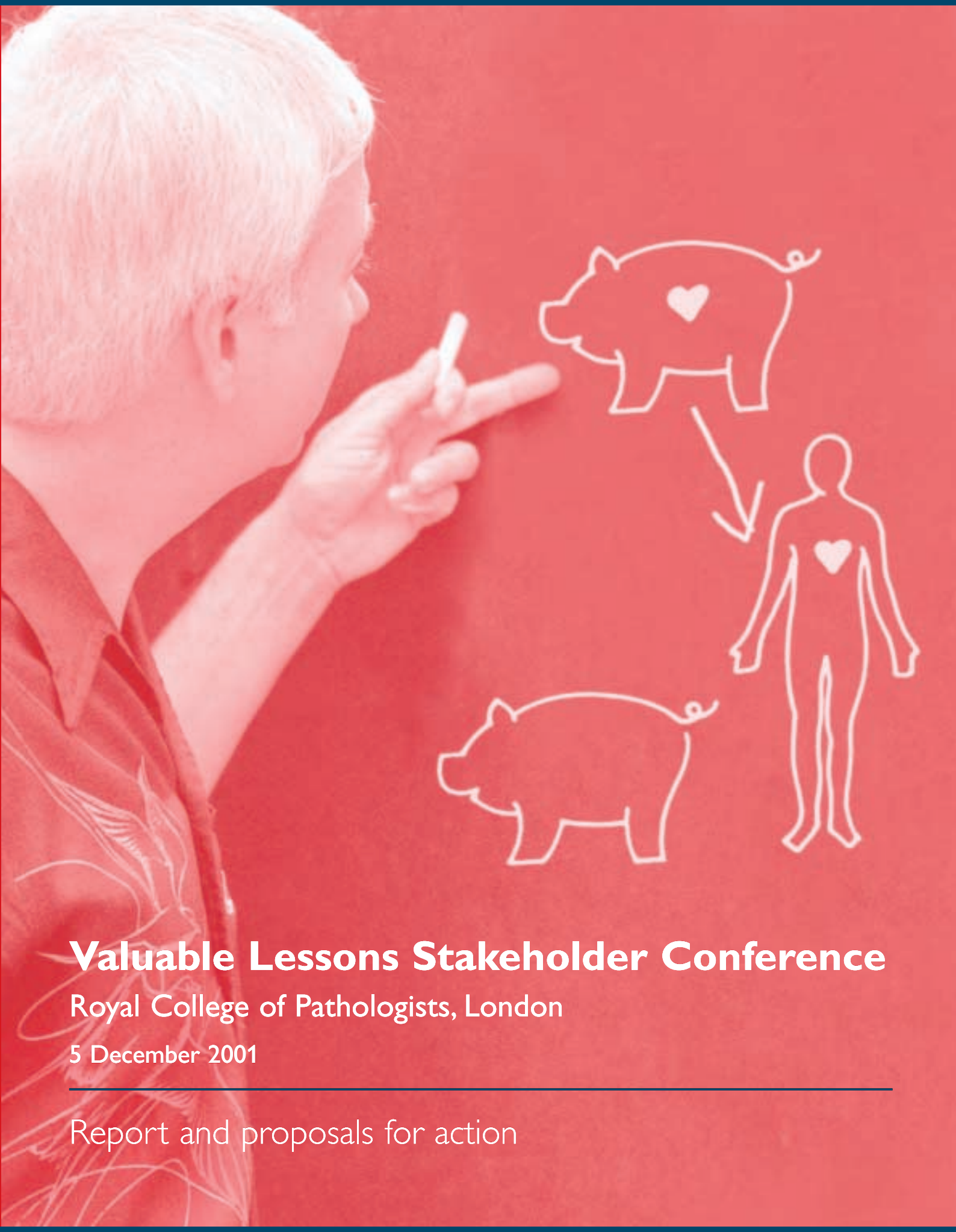

Valuable Lessons Stakeholder Conference

Royal College of Pathologists, London

5 December 2001

Report and proposals for action

The Wellcome Trust

Written for the Wellcome Trust

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February 2002

On 5 December 2001 the Wellcome Trust held a conference at the Royal College of Physicians, London, to explore the implementation of recommendations of the research report *Valuable Lessons.* This report details the activities and outcomes of the Stakeholder Conference and highlights delegates' views on what needs to be done to ensure that the recommendations are enacted.

Contents

Executive summary

The conference was a follow-up to the report, *Valuable Lessons: Engaging with the social context of science in schools*. The report found obstacles to classroom discussion of the social issues associated with biomedical science. The meeting was designed to generate proposals for how these obstacles might be overcome.

Around 80 delegates involved in education spent the day discussing the desirability and feasibility of implementing some of the recommendations.

- There was general agreement that teaching science in a social context should be part of science education, probably throughout but especially at Key Stage 3 (KS3). This stage seemed the best place to start and preferably not later, partly because there was more flexibility in curriculum content. It should, however, be consolidated later on, though this might be harder to implement.
- While science and social issues should be part of science education, this did not imply they should be left to scientists. New combinations of skills and practices would be needed. These need to be actively promoted and backed up with support for teachers.
- Cross-curricular working seemed almost by definition a suitable way to tackle such issues, but the scope for carrying it out seemed limited. We need, somehow, to capture the qualities sought through cross-curricular working within existing curriculum divisions. At the very least, this will mean building new working relations between science specialists and other teachers. The introduction of citizenship as a topic may be the best opportunity to start doing this.
- After a presentation based on a similar project in Germany, delegates had further group discussion to generate ideas for a response to the needs identified in the original report. Each group considered how to move at a different level of the national education system, but there was clearly a general view that effective proposals needed to link the levels.
- A nationally significant effort would probably need ministerial backing for high-level endorsement, for moving the levers which control existing institutions, and, perhaps, to resource a ‘national centre of excellence for science teaching’. A nationally prominent research project would also provide a focus for discussion and policy deliberation.
- Intermediate-level support would be needed for resource development and review, and for local agents to promote or expedite new initiatives. They might be ‘science ambassadors’, information officers, local ethics coordinators, INSET (in-service training) specialists, local education authority (LEA) science advisers with special responsibility, or even Office for Standards in Education (OFSTED) personnel – but they would need to be identifiable. They would be heavily involved in local or regional meetings to agree policy and spread good practice.
- Dissemination works best when there is teacher-to-teacher contact.
- Local or institutional support would then focus on exploiting local resources, adapting generic materials for local use, breaking down barriers between departments in schools, and securing resources to enhance teachers' confidence and skills as they move into unfamiliar areas.

A final impression was that producing significant educational change is difficult, because of attitudes and structures fostered by the various UK National curricula, but not impossible. There are convincing arguments and gathering opinion that change is needed. But for real progress, it does seem that a large selection of these recommendations need to be implemented, and all in step.

1. Background

"As developing citizens young people should develop the analytic skills that will enable them to use ethical reasoning when considering scientific and other controversies. They should be empowered to discuss the issues of the day using their scientific knowledge within an ethical context."

And who could disagree? However, spelling out proposals and making them happen are two different things. The *Valuable Lessons* report,[1] commissioned by the Wellcome Trust from the Institute of Education in London, concluded that young people 'should' benefit in this way from their education and made clear that organization of curricula, classrooms and schools presents obstacles to establishing a dialogue about how science will affect all our lives.

Valuable Lessons looked at how controversies in the biosciences were dealt with in schools and colleges in England and Wales (see Appendix on page 15 for the executive summary of the *Valuable Lessons* report). The researchers found widespread support among teachers for tackling such issues, but many problems when it came to actually doing it. Science lessons are rarely built around discussion, but teachers in subjects where there is discussion are unsure of their ground in science. Curricula are fact-filled, and assessment often encourages knowledge rather than argument. Collaboration between subject teachers can be difficult inside existing structures, and teaching resources are often lacking.

However, none of these problems are insurmountable – as some existing initiatives also showed – and the report made a number of recommendations for taking 'science in society' education forward.

The meeting, chaired by Professor Nigel Paine, Director of Science Year, was organized to assess these recommendations. Eighty people with a close interest in science education spent a day working on feasible ideas and how they could be implemented. The day was carefully structured, with advice from Perry Walker of the New Economics Foundation and Melanie Smallman of Think-Lab, to ensure everyone had a chance to add opinions and expertise to the mix (and that they had to work hard!). Activities were designed to review the research recommendations and then devise ways of taking them forward. The resultant views are an invaluable supplement to the quantitative and qualitative data analysed in the earlier report, and provide an informed basis for further action.

The details of the activities[2] followed a logical sequence. The results are taken in order, beginning with the participants' aims for the day. Final recommendations for action are at the end of the report. For those recommendations only, please turn to page 14.

1 *Valuable Lessons: Engaging with the social context of science in schools*. Recommendations and summary of research findings. The Wellcome Trust, 2001. Full report available at www.wellcome.ac.uk

2 Although this is a meeting report, not a piece of social science, it is worth noting that the activities given to delegates, in a number of small groups, generated a fair quantity of notes from within each group, as well as various collective representations like charts, graphs and flip-chart notes. I have not attempted to do full justice to all this material, but to focus on areas of agreement and, especially, priorities for action. Where I have tried to underline particular points using unattributed quotes they come either from notes supplied by the groups or from my own notes taken while sampling the discussion more or less randomly. A separate note is available on how the discussion was organized, and how well it worked.

2. Hopes and expectations for the meeting

When those invited were asked to set down the three things they wanted to get out of the day, they suggested:

1. Realistic paths to implementation
2. Ways to change the curriculum
3. Ways to increase teachers' confidence.

3. Further context

Ralph Levinson, of the Institute of Education and co-author of *Valuable Lessons*, outlined the important encouragements and constraints shaping responses to the report's recommendations. He emphasized that teaching science in its social context implies dealing with controversy. There will be differences of opinion linked to differences in values. This kind of teaching is not new to schools, and past efforts such as the School Humanities Project or science, technology and society courses offer useful experience.

Students certainly respond well to controversial issues and will raise them of their own accord, but such issues tend to highlight the power relations of the classroom. Students will discuss them in very different terms with a teacher than they would among themselves.

Current developments relating to social issues in science include the new citizenship curriculum, which would be enormously important (and where the Wellcome Trust is already working with the Association for Science Education to develop materials for KS3). However, in science controversies statutory requirements for 'balance' could inhibit teachers – especially headteachers. This was especially unhelpful when balance was interpreted as 'leaving pupils to make up their own minds', as this made it harder to focus on argument.

Handling controversy was also inhibited by science teachers' discomfort when faced with strong feelings. Recent experience of the curriculum has led teachers towards standardization and into a kind of acquiescence: they saw themselves as 'delivering, not devising the curriculum'. And even though, historically, it is easy to show science as a battle of ideas, this was not a panacea for dealing with a science curriculum laden with content.

Finally, Ralph Levinson highlighted issues of examinations, assessment, school policies and, perhaps most challenging, organization. The scope for discussing controversy was influenced not only by whether the classroom atmosphere was authoritarian, but also by general features of schools. A school needed to create "the kind of environment in which it is worth expressing an opinion".

4. Where in the curriculum?

After this slightly daunting range of issues had been presented, the eight groups of delegates were asked to debate something more specific. Social issues in science do not have a clear, unambiguous place on the current map of subjects taught in schools today. So where to put them? Delegates were asked to consider both desirability and feasibility of instituting such teaching within:

(a) Science

(b) Citizenship

(c) English

(d) Religious education (RE)

(e) Personal, social and health education (PSHE)

(f) Short philosophy courses

(g) Cross-curricular working, such as collapsed days.

Groups' basic views were indicated by ratings on a simple chart. In this index, science was unanimously voted the preferred subject to target. Citizenship was an equally clear second choice (for six out of eight groups), with cross-curricular working in third place.

This showed the desired subjects. But what was feasible? Here, the result was slightly less clear-cut, but the rank order was the same. One or two groups felt it would be easier to institute science and society teaching in cross-curricular fashion, or under citizenship, than in science proper. But there were still generally low scores for the other suggested areas. Just one group rated philosophy high on both desirability and feasibility, but it was zero-rated by several other groups. So perhaps those supporting philosophy have a job to do telling everyone else what it involves.

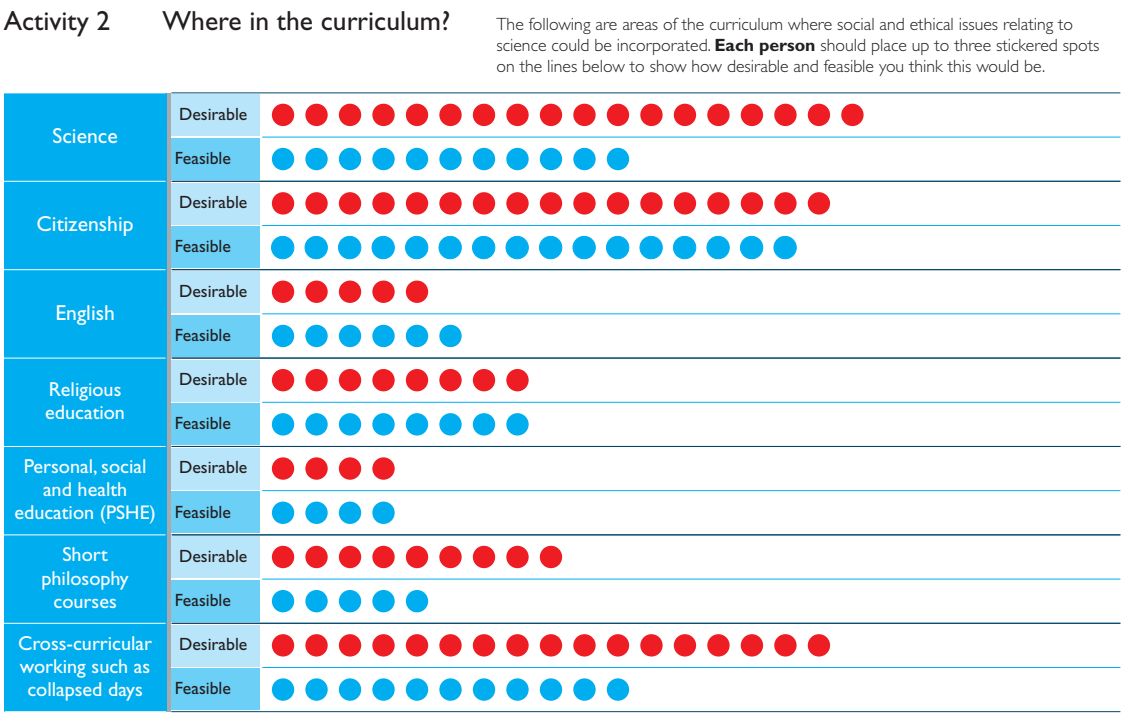

Fig. 1: Example of one group's ratings of where social and ethical issues could be incorporated into the existing curriculum.

In discussion, the groups brought up a range of arguments. Overall, there was a strong view that students needed skills in argumentation and discussion, and the ability to apply them in a science context. There was also a need for a coordinated approach, avoiding repetition, and creating a sensible progression (though this may have been a comment about the current state of the science curriculum). Feasibility was generally dependent on serious support and the attitudes of teachers. Some felt that this first, simple question was too complex to produce a straightforward preference. But we had to start somewhere, so the pros and cons of each went roughly as follows:

Science

This should be the best place to start (probably during Key Stage 3, though some wanted a foundation in primary schools). Science was the obvious mainstream curriculum area, and handling these issues ought to be part of being a good scientist. Looking at science in a social context needed to be mainstreamed, not marginalized. It would not work as a 'bolt-on' ethical component (see PSHE). This would be no good if it were exclusively in science – or solely the province of science teachers. However, if science and society issues were tackled elsewhere, science teachers would still need to be involved.

Citizenship

This new area offered important possibilities – it was already clear that working to meet the new requirements would need cross-curricular approaches and cooperation between departments. There are still sceptics – teaching 'how to live' to meet a government prescription evoked some reservations, but it would provide a new starting point, with structured debating part of the specification. The feasibility of tackling science and society issues would be determined locally – by school organization, and the degree of collaboration between science and other departments.

English

The strength of English was the tradition of discussion. "They'll come out of an English lesson where they discussed and feel they did some work," said one delegate, whereas a science lesson where "nothing got written in the book" would feel odd. English teachers were also accustomed to assessing discursive writing. Even so, there was little enthusiasm for extending the English curriculum in this direction, although science fiction might offer possibilities.

Religious education (RE)

RE already involves controversial issues and debate. But the spotlight on belief, often supported by strong personal feelings, meant that targeting this area "could create more problems than it solves". RE teachers would have difficulty sourcing information for science issues.

Personal, social and health education (PSHE)

PSHE had its good points, especially flexibility and experience in debating controversial or emotive issues. But this came with a serious downside – low status, limited time and, tactfully: "sometimes problems of perception on the part of students and staff as to the worth of the programme".

Short philosophy courses

These were seen as highly desirable by some, but otherwise not attracting much comment. Note, though, that there were few humanities educators able to come to the meeting, so the results may be skewed away from philosophy. It is also the case that there is little tradition of teaching philosophy in UK schools, so little experience to go on. This relatively unenthusiastic response could be contrasted with recent proposals in France to teach philosophy to all science students.

Cross-curricular working and collapsed days

These were seen as desirable, but hard to do. They would be limited by pressure of other curriculum content, funding and staff commitment. Collapsed days – when the school curriculum is suspended for a day or part of a day and a whole year group engages in a themed programme of events and activities – could provide a stimulus, a 'kick start', but would only ever play a small part. They could even be an admission of defeat, and could marginalize the issues. It would also be difficult to raise the science to an adequate level in a single day. Longer-term modes might be more promising. In France, for instance, cross-curricular writing is a requirement, with its implementation left up to the school.

Other subjects not listed, notably drama and history, were also mentioned as worth considering.

5. How?

Deciding which part of the curriculum lends itself to debate on science and society is a start, but not much more than that. What exactly can we do to make it happen? In this next part of the discussion, the eight groups were asked to place six possible enabling measures in a space defined by the same two variables as before: desirability and feasibility. The six proposals were:

- Greater clarity in examination specifications and syllabuses
- More flexibility in specifying the curriculum
- Developing methods of formal assessment of these skills
- More teacher support through professional development and educational materials
- Promotion: encouraging more post-16 students to take a science course
- Improving cross-curricular coordination.

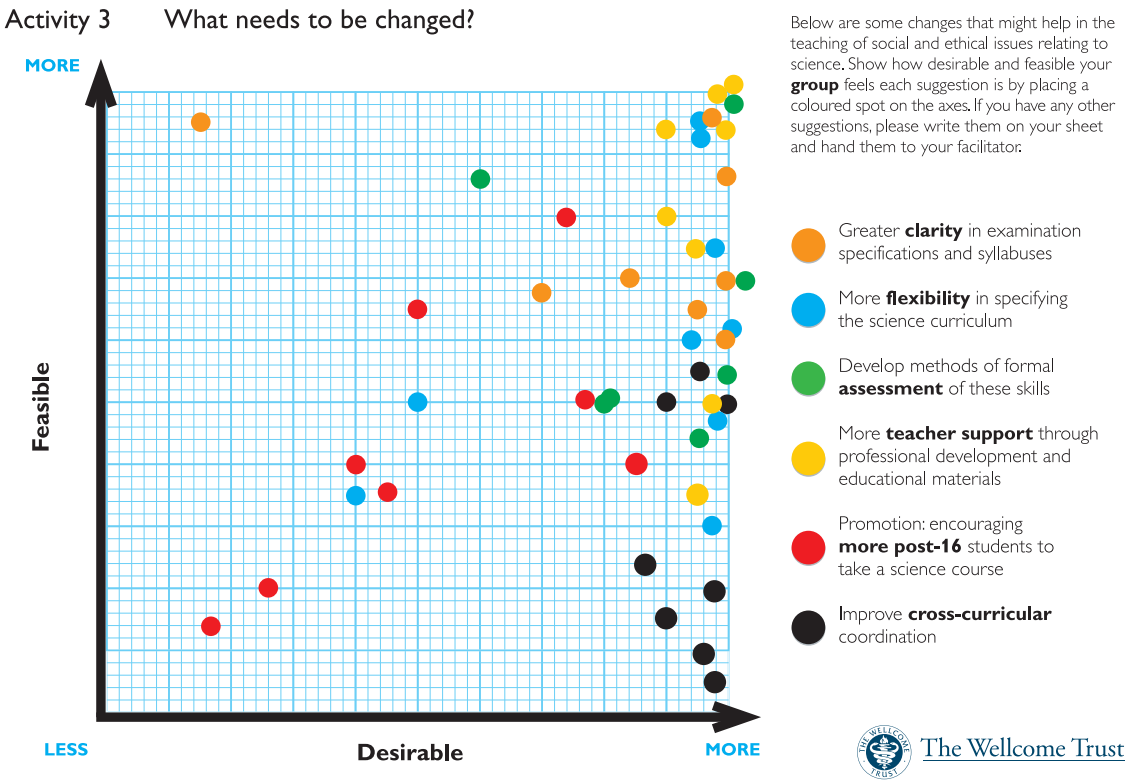

Fig. 2: Participants' views (all groups) on what could be changed to enable the teaching of social and ethical issues relating to science.

When the verdicts were combined in a single chart (Fig. 2), almost all the recommendations were seen as desirable, whereas some were seen as more feasible to implement than others. With the exception of promoting post-16 courses, all these suggestions were clustered in the desirable region. There was one solitary band of enthusiasts for promoting post-16 courses, but most others saw this as less desirable. This was based on grounds of relevance to the problem, rather than lack of enthusiasm for the courses in question (the AS level in science for public understanding being the most obvious example). The general view was that the job has to be done before age 16 in a way that reaches the whole cohort.

Increasing flexibility and developing formal assessment evoked less than complete unanimity. This was partly a matter of interpretation. Did flexibility mean ability to vary curriculum content or assessment outcomes, or to shift timetables around, or not to do some things at all? Did it mean choice for teachers or students? The meeting veered towards prescription in interpretation. Flexibility that enabled things to happen was helpful; flexibility that allowed people to opt out of doing what was believed to be a 'good thing' was not.
The original recommendation in *Valuable Lessons* proposed that: "We would like a lot more flexibility about content, but require the inclusion of social and ethical issues."

Similarly, how formal was 'formal assessment'? Ideally, it might mean "whatever way you do it you come out with a grade". Some felt that developing this further was unnecessary, as it is already working perfectly well where needed. Some felt that it was not desirable, but "sadly necessary". Others emphasized that there is a pool of teachers who would like to take up science issues even if the work was not assessed. Nevertheless, the majority of groups thought some effort in this direction was desirable, and a few rated it highest of all.

Feasibility was another matter. Judgements varied between topics and between groups. Again, there was scope for interpretation – short of contravening the laws of physics, surely just about anything could be feasible if you have the authority to force it through, or the resources to promote it. Some of the unresolved issues here were picked up in the final exercise. Generally there was, however, a clear consensus.

Improving cross-curricular coordination was consistently seen as infeasible, however desirable it might be. "Even physics and maths cannot be fitted together as the separate curricula do not necessarily teach things at the right time". This seems hard to square with the view elicited above that teaching science and society was especially feasible in cross-curricular fashion. Perhaps the simplest interpretation is that it would be feasible to tackle these issues as part of cross-curricular work, if there were any.

More teacher support was rated as highly feasible by half of the eight groups (and lowest by one). Two felt improving flexibility was highly feasible, while the rest of the results were mainly in the middle range. Improving clarity might be feasible, but was a "necessary but insufficient condition". Clarity could be helpful but could also lead to over-prescription. "It depends on the content of the syllabus".

Teacher support also attracted lengthy comment about desirability. There was a need for materials both for students and teachers, to make it easier for teachers to deliver: "Teachers haven't time to search endless websites and books for something they can use". They need 'off-the-shelf' resources to get them going, they may then move on to develop their own materials as their confidence in the area increases. Teacher support would also make cross-curricular working more feasible.

6. First stocktaking

At this stage the following views had emerged. Teaching about science in a social context should be part of science education, probably throughout but especially at KS3. Key Stage 3 seemed most appropriate because there is greater flexibility in curriculum content and after KS3 it may be too late to incorporate these issues. There should be further consolidation of science and society issues at a later stage, however this may be harder to implement.

While science and social issues should be part of science education, this did not imply they should be left to scientists. New combinations of skills and practices would be needed, which need to be actively promoted and backed up with support for teachers. Cross-curricular working seemed almost by definition to be a suitable way to tackle such issues, but the scope for actually doing it that way seemed limited. We need, to capture the qualities sought through cross-curricular working within existing curriculum divisions. At the very least, this will mean building new working relations between science specialists and other teachers. The advent of citizenship as a topic may be the best opportunity to start doing this.

7. An overseas experiment

Before the final, most challenging group discussion, Professor Michael Schallies (University of Education, Heidelberg) described a German project that offered some pointers.[3]

Professor Schallies's team worked with almost 100 teachers and more than 3000 secondary school students in southern Germany to develop their discussion of biotechnology and genetic engineering. They undertook classroom project work in ten schools over a school year, aimed at promoting:

- teaching of 'non-reduced' concepts of science;
- conscious use of ethics as a tool for reflection; and
- interdisciplinary teaching.

To begin with, the students reported that they felt ill prepared to deal with current problems of science and technology and they (like their teachers) received most of their information from the media. The project teaching was broadly successful in increasing confidence in handling such issues, and the results showed that the type of arguments used developed through the age range (10–21). The goal of reaching an 'undecided, but balanced' response was quite often achieved. "This is what you want people to leave school with," said Professor Schallies.

8. Modest proposals

After this clear indication that high-powered intervention can produce results, albeit in only ten schools, it was back to the difficult problem of producing results for an entire country. This was the most important part of the meeting, and also the hardest to summarize. Most groups were asked to assume one of three roles: headteacher, director of an educational charity, or education minister. Two were given a general brief. The roles were chosen with the need for change to be implemented at a number of levels. This is what the proposals clearly recognized. In each case, we had to look at the specific areas for action highlighted earlier in the day, and consider how to implement them (if both feasible and desirable) or how to make them more feasible. This distinction became blurred in most of the discussions.

3 Further details can be found at www.ipn.uni-Kiel.de/projekte/esera/book/b079-sch.pdf

With eight groups at work, not all the headings were covered. Not all headings that were discussed were treated from all points of view, but the exercise produced a wealth of proposals. Some of the more straightforward ones are under the headings given above in section 5:

- Clarity
- Flexibility
- Assessment
- Teacher support
- More post-16 students
- Cross-curricular coordination.

Impressively detailed schemes designed to bring together a number of these aims are discussed separately below.

Some 'headline' proposals

To foster greater clarity:

The minister could: Ask the Qualifications and Curriculum Authority (QCA) to map where social and ethical discussion already takes place;

Use a cross-curricular team to make recommendations after reviewing the map;

Sharpen up specifications for exams in science and/or elsewhere.

A headteacher could: Liaise with other schools and teachers (past and present), and arrange a day with representatives from awarding bodies to discuss assessment and flexibility.

To ensure flexibility:

The minister could: Reduce testing and use of league tables, and tone down direction from government and their agencies.

To improve assessment:

The minister could: Support a high-profile research project on assessment, which would feed into teacher training.

To improve teacher support:

The minister could: Create a national centre for excellence in science teaching to coordinate information and training.

An educational charity could: Review existing resources (rather than hastening to create new ones), with a view to funding dissemination – either by simple distribution or paying for supply days.

A headteacher could: Nominate an information officer to compile a database of resources.

Organize mixed INSET days.

However valuable these individual items might be, they do not really capture the flavour of the groups' recommendations. They miss out on two things: the level of detail on offer and, in most cases, the emphasis on a coordinated approach, with action on several fronts and at different organizational levels.
To demonstrate, here are some examples in full.

Scheme 1 – For a headteacher

To enhance teacher support

(a) Continuing professional development (CPD) to be led by head of department, possibly targeting KS3 first

Support and evaluate experimentation. Stimulate and motivate department (use departmental meetings)

CPD for teachers in second year

Compile materials for CPD and an e-mail list

Programme will need stimulus materials, information on resources

Wider range of ideas on how to use new and existing resources

Videos on classroom practice examples

Could all be coordinated through a website

Needs finance from DfES and partners

National Centre for Excellence in Science Teaching – could coordinate information and training in the future

(b) Education materials

Stimulus materials and ideas for their use

Articles (topical/current)

Videos/clips

Pictures

Paper/web-based resource list (assess material for biased viewpoint)

Case studies, based on role-plays or drama

Materials may only be needed in the short-term. Publishers will put it into textbooks once professional training has taken hold.

Resources linked to exam board syllabuses (e.g. with built-in web links?)

Scheme 2 – For a headteacher

To launch cross-curricular working

1. Develop a set of cross-curricular themes, such as social and ethical issues relating to science. Via head of faculty meeting in consultation with departments.
2. Estimate time/INSET required to deliver these themes in various year groups. Or decide to have impact session first, e.g. whole school focus.
3. Add impetus by cooperation with outside party/media/funding.
4. Initial collapsed day planned.
5. Follow up activities agreed across individual departments, e.g. news wall, media events, visiting speakers, website, drama, music, assembly, dance.
6. At the end of a period where such work has been going on, public finale – tying things together with a talk or event, and celebrating young people's contribution.
7. Evaluate to see how to continue next year.
8. Head to monitor future development via feedback from departments, observation etc.

Once the all-singing, all-dancing cross-curricular event or follow-up has happened, it needs to be shared locally and nationally, and the process disseminated, in order to:

- spread good practice;
- celebrate staff achievement and work and boost staff and students' morale;
- produce a more profound drip-feed effect on the curriculum (or even more wholesale change).

Necessary prerequisites for all the above:

- Staff onside
- Money
- A good head teacher
- A successful school
- Educational justification.

"It is easier to get something interesting to happen by completely disrupting the curriculum."

Scheme 3 – For an education charity

A research and development approach.
Assuming: some flexibility is available at KS3, 4, 5 – and that we wish to exploit it.

- Research and development
- Clarify educational aims
- Identify structural opportunities in different kinds of schools
- Identify individual schools wanting to take part in development project – with their own objectives (two-way mediation)
- Draw up in-house CPD programmes
- Support networking of schools involved
- Ongoing evaluation
- Devise teaching resources (of publishable standard) to support educational aims
- Analysis and dissemination to wider pool of schools

Plus parallel projects with ITT providers

Charity initiates with around £5 million

Larger scale should be state-financed

Scheme 4 – For an education minister

A set of initiatives.

General – Following consultation with teachers.

Keynote address – Why is science in context important to learn and teach? Minister to review in five years.

Call for a coordinated approach:

- Assessment
- Teacher support
- Cross-curricular

For 'tomorrow's science citizens', today:

A national centre for teaching excellence

- National resource
- Inclusive
- Easy access
- Two-way resource
- Rewards (linked to professional development and appraisal)

High-profile research project on assessment

In partnership with researchers and teachers

Adapting assessment methods from all disciplines, cultures and contexts

National conference (after two years) on outcomes (feeding back into training through National Centre for Teaching Excellence)

Compulsory cross-curricular day (for students)

Clearly, one could pick and mix from these suggestions, and the individual items need not be divided between promoters or funders. A charity could expedite much of the work in schemes 1 or 2, while government could be persuaded to support the programme outlined in scheme 3. But it is worth setting the schemes out in this way to emphasize that most of the groups were thinking in terms of coherent sets of activities, rather than single initiatives – with both local and national coordination.

As one group expressed it, the aim is to create an 'experiential learning cycle' lubricated with cash, to transfer good practice from active teachers to those who are sceptical or not doing anything, and spread this through involvement of QCA and awarding bodies.

Other themes which emerged in the discussions included information review and dissemination. There was a feeling that it would be easy for enthusiasts to produce 'resource overload' without a regular inventory of what people were doing. This could be allied with quality control, where there were plenty of possibilities for bringing in outside organizations to stimulate discussion, or simply to use their material – but there were concerns about how to avoid bias.

9. Second stocktaking and conclusion

This was, in the end, one day's discussion with one set of people. They varied in outlook and ambition – some seeking wholesale change in science teaching, others willing to settle for saying, "this is how some science could be taught". That said, there was an impressive level of agreement, both during this set of exercises, and with the diagnosis of the original *Valuable Lessons* report.

There were enough innovative ideas to begin thinking seriously about effective action in this area. A complete package would involve a carefully mixed blend of exhortation and systems thinking, and could work on three levels.

A nationally significant effort would probably need ministerial backing – for high-level endorsement, for moving the levers that control existing institutions, and, perhaps, to resource a national centre of excellence for science teaching. A nationally prominent research project would also provide a focus for discussion and policy deliberation.

Intermediate-level support would be needed for resource development and review, and for local agents to promote or expedite new initiatives. They would be 'science ambassadors', information officers, local ethics coordinators, INSET specialists, LEA science advisers with special responsibility, or even OFSTED personnel – but there would need to be identifiable people devoted to this area. They would be heavily involved in local or regional meetings to agree policy and spread good practice. Dissemination works best when there is teacher-to-teacher contact.

Local or institutional support would then focus on exploiting local resources, or adapting generic materials for local use, breaking down barriers between departments in schools, and securing resources to enhance teachers' confidence and skills as they move into unfamiliar areas.

The final impression is that producing significant educational change is difficult, though not impossible, because of the attitudes and structures fostered by the development of the UK National curricula. There are convincing arguments and gathering opinion that change is needed.

The meeting was generally accounted a success. Whether it was truly successful, of course, will depend on how many of the proposals are actually taken forward.

10. Appendix: Executive summary of the Valuable Lessons report

The ability to engage in discussion about the impact of science on society is increasingly seen as an essential part of young people's education. Some examples of good work currently exist in schools and further education colleges, but these examples are comparatively few.

An interdisciplinary team from the Institute of Education, University of London, carried out research for the Wellcome Trust in which they sought to uncover how, and in which curriculum subjects, controversies arising from bioscience are tackled in schools and colleges in England and Wales. The aims of the research were to highlight good practice, identify institutional obstacles, and find ways of enhancing young people's experience of science education, preparing them to engage confidently with the issues that they are likely to face in the future.

The study showed that 60 per cent of teachers from all types of institutions and all subjects think that there is too little coverage of the issues related to biomedical science. The majority of all teachers interviewed felt strongly that students should have an opportunity to explore such issues. Teachers view this kind of exploration as vital in building self confidence, developing lines of critical thinking and enabling students to deal with socio-scientific issues in a balanced way. They also consider that it engenders sensitivity towards the rights and needs of others.

Currently, the majority of science teachers consider it their role to present the 'facts' of their subject and not to deal with associated social or ethical issues. In general, science teachers feel that they lack the skills, confidence and the time to initiate and manage classroom discussion. Much could be learned from their humanities colleagues who demonstrably promote student discussions of ethical and social issues.

Science teachers highlight the existence of formal assessment as a major factor in determining the level of coverage of socio-scientific issues. Most science examinations reward knowledge and understanding rather than well-reasoned argument. Innovative mechanisms for assessing students' ability to present reasoned arguments are identified as essential for young people to engage with these issues.

Teachers of science should be supported to engage their students in discussion about these issues, through high-quality professional development, through the production of appropriate educational materials, clearer guidance from awarding bodies and with greater flexibility in their teaching.

Humanities teachers appear most confident when covering general ethical and social issues; they feel significantly less confident though about addressing socio-scientific issues. Many consider the scientific facts incidental to their teaching of issues-based topics – a source of concern for science educators who feel that disregarding the science and its accuracy reinforces student misconceptions.

The research identifies successful components of existing courses and strategies for sharing skills and knowledge among science and humanities teachers. Teachers of humanities and Personal, Social and Health Education (PSHE) should have access to educational resources that clearly set out the science and the issues it raises.

A lack of collaboration between different subject departments currently exists in schools. Science is perceived as value free and humanities as value laden. This results in the teaching of facts and the development of opinion and moral reasoning being kept separate. However, one promising model of cross-curricular collaboration identified is the 'collapsed day' – during which teachers work together to take students off-timetable to explore a theme. The introduction in England of Citizenship Education in 2002 could act as a catalyst to facilitate greater coordination among science, humanities and other teachers and develop closer working ties.

If future generations are to engage with the issues raised by science in a considered and responsible way, the education community must confront a range of challenges. These include establishing a clear philosophy about what science education should be, and how to resolve the demands of a conventional science education with a curriculum that examines science in society. The science curriculum in particular needs to provide the flexibility for teachers to explore the power and limitations of science within an ethical framework.

Full report available at: www.wellcome.ac.uk.

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