2020

Science Education in a Changing World

Edinburgh International Conference Centre, 5-7 March 2003

Summary of Proceedings

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Background

In January 2001 the Scottish Executive published *A Science Strategy for Scotland*. This report signalled that particular attention was to be focused on science in Scotland, both at the level of research and industry as well as within education. The Executive Summary of the Strategy document made clear references to the importance of science education. Two key aims were identified: to 'secure very high levels of achievement by those specialising in science' and to 'ensure that **all** learners acquire the capacity to cope as citizens and decision makers when dealing with scientific issues.' The Strategy also included strong messages about the importance of the communication of science and the need to consider public attitudes towards science.

As part of this special focus on science education the Executive made a commitment to organise an international conference of science educators to consider innovative approaches to the teaching of science at school and post school levels including community education and the wider public understanding of science across society.

This report records the key contributions to the conference. A conference report, aimed at a broad audience, will be published in due course. The report will highlight some of the key recommendations emerging from the conference.

Day 1. Wednesday 5 March.

Science Curricula in school and beyond

Nicol Stephen, MSP. Deputy Minister for Education and Young People

Mr Stephen offered an overview of the strengths of science education in Scotland, making references to the popularity for science in terms of student uptake at school and the heritage of science research in Scotland. He charted the issues facing the science community and these included the closure of physics departments in Higher Education, the downturn in enthusiasm for science in secondary school and the need to update both the quality of learning environments and teacher professional development. To this end the Deputy Minister announced the allocation of an additional £10 million over three years to boost science education in schools. He also announced that the Scottish Science Advisory Committee would be considering the future of school science as part of a broader review of the 5-14 curriculum.

Mr Stephen explained that one of the challenges facing the science education community was to ensure the flow of scientists and engineers from schools into research whilst at the same time providing an education which allowed all people to play a full part as informed citizens in our democracy. He saw a real need to make better use of the innovation and energy within Scottish research to allow enterprise and risk takers to flourish. He believed that by encouraging a culture of enterprise and innovation, Scotland might attract science innovation and so benefit from economic success and an improved quality of life for all.

Dr. Jack Jackson.
Current issues in Science Education.

Dr Jack Jackson highlighted the main thrust of the Science Strategy for Education, which is that all learners should develop science capability, and that in addition there should be high achievement for those aspiring to become science specialists. Young people must have subject knowledge, the ability to interpret data, to evaluate benefits, to carry out investigations to show an interest in, and enthusiasm for, science.

He then went on to outline the strengths (good progression, popular courses, up-to-date content, balance of knowledge/skills/attitudes) and weaknesses (primary science, S1/2, gender imbalance in S3-6, recent drop in uptake at Higher) of our current science curriculum.

Finally he identified strengths (primary teachers are generalists, most secondary teachers are honours graduates and very experienced, and currently supply meets demand) and weaknesses (most primary teachers have no science background and lack confidence in the subject, subject knowledge and skills are not covered in training, there is a shortfall in technician services) of our current school science workforce.

Day 1. Session 1

Dr Richard Wiseman
The cabinet of wonder

Dr Wiseman is interested in creativity and effective thinking. He demonstrated very clearly the phenomenon of "Inattentional Blindness" by showing a video sequence in which the audience had to count the number of bounces of a basketball. The majority of the audience failed to notice the entrance of a huge "gorilla" part way through the sequence!

Professor Brian Arnold OBE
School Science in Scotland: A Personal Perspective

Brian Arnold started his talk by indicating that if one listened to the news it would be easy to think that science teaching is stuck in the 1960s. He disagreed with this and then went on to give a historical summary of how things have changed over the last forty years from the 'show and tell' teaching of the 1950s through the domination of worksheets in the 1980s to the 5-14 and Higher Still developments of recent years. He argued that Scotland's new curriculum should be responsive to contemporary needs. It must also be brave enough to shake off the iron grip of national assessment.

Brian Arnold's wish list for the future included:

1. The loosening of the grip of national assessment.
2. Great chunks of content cut out from the curriculum.
3. Reduced use of worksheets.
4. Secondary schools that begin to recognise Primary attainment.
5. Pupil interests to be taken more seriously.
6. The needs of the teaching profession attended to in addition to those of the learners.

Dr Susan Rodriguez, Institute for Science Education in Scotland.
Science Education: A Snapshot of Potential into Practice

Dr Rodriguez outlined a CPD model, the Partnership in Primary Science (PIPS) project, showing 2 video clips to exemplify the work. Particular characteristics of the project were that teachers participating in the project had face to face contact every month, and regular electronic contact, with other teachers in the project. Projects in primary schools were developed by educationalists and other external agencies working in partnership with teachers in primary schools.

Dr Bonnie Dunbar, NASA Astronaut and Assistant Director of the Johnson Space Centre.

Dr Dunbar charted some of the key landmarks of discovery in space over the past 100 years, including the recent interest in bioastronautics and small scale nuclear power sources. She explained that the United States is also interested in reversing the trend away from sciences at school and at university and wanted to challenge the public perception of science and scientists. Part of our job, she concluded, is to take the dreams of children and turn them into a reality for tomorrow. Later, Dr Dunbar held a special audience for young people at which she was questioned on such issues as future plans to go to Mars, the training of astronauts, the problems with space debris and the possibility of life beyond Earth.

Scottish Space School Foundation

Three pupils who had attended Space School 2003 at the Johnson Space Center in Houston USA gave us an extremely interesting presentation. They described various aspects of the selection process, the journey to Houston and the various training exercises and simulations which they took part in. The skills developed included teamwork, communication, creativity, enterprise and budget.

Day 1, Session 2

Giant productions: Up the stairs and in the attic.

A presentation was given showing this exciting theatre production which toured schools as part of Science Year. This showed how theatre in science can enliven science education and get the message across in a fun and interesting way.

Panel Session: Science Education – Any Questions?

Three of the panel members briefly presented their vision for science education.

Dr Derek Bell, Chief Executive, ASE

Dr Bell began by describing his vision where "Students and teachers are working together and learning in partnership. The students learning skills such as literacy, numeracy and citizenship through science as well as learning from science".

In order to achieve this vision we require:

- Enough science teachers
- Adequate up-to-date resources
- A society where science is appreciated
- Science to be fully interdisciplinary

Professor Alan Roach, Dean of Science, University of Paisley

Professor Roach raised a number of concerns and issues which need to be addressed in order to provide his vision of the future. These included:

- a new science curriculum that connects with the world through applications and issues and which can be allowed to develop more freely, in particular in response to local needs and teacher's initiatives.
- a system that breaks free from the traditional "knowledge ladder" approach to provide university "entry knowledge" and in so doing frees children from the 'tyranny of the exam'.
- A school science which is more multidisciplinary and includes engaging children in the excitement of engineering.
- A school science which presents a story of intellectual struggle and achievement, resulting in science as the pinnacle of human achievement.

Walter Whitelaw, Midlothian Council Education Department

Mr Whitelaw began with "Hurrah for science teachers – they are doing a good job".

Mr Whitelaw's vision for science education was based around: flexibility; understanding; positive image and fun. In 2020 he hoped there would be:

- A seamless transition from Primary schools to Secondary schools
- Less descriptive science but more understanding
- New resources for science teaching
- Interactive science teaching
- More education/industry co-operation
- A Scottish Science Education Trust funded by industry

Day 1, Session 3

Professor John Brown, from the University of Glasgow showed the potential of magic as a teaching tool. Professor Brown was followed by a spiritual meeting with astronaut Gene Cernan, the last person to step on to the Moon. Gene Cernan was recreated on stage by the **Spectrum Theatre** company.

Round table. Science Education – any answers?

The conference divided into round table working groups to consider issues relating to science curricula and schools. A summary of the key issues is given here under a number of sub-headings.

A. The curriculum

- There is a need to look at science education in schools as continuum from 3-18 so that all the learning fits together including the assessment and reporting.
- There needs to be a reduction in the content of knowledge so that there is more time for skills, problem solving, discussion and investigations. There is more need for students to understand the "big picture" and have a more holistic understanding.
- We should look at best practice from other curricular areas in how they tackle problem solving in an exciting way
- Science learning should be fun and employ a more investigative approach.
- There is need to show students the relevance of learning and applying science to their future lives across the range of abilities.
- Consideration should be given to more integration of the sciences and mathematics to avoid duplication of teaching.
- There is too much assessment in science education.
- There was a question about whether we actually need breadth and balance in the curriculum. Would it not be better to inspire real enthusiasm about fewer things.
- The increased use of virtual reality has positive and negative aspects. We must not lose a "hands on" and truly experiential approach with real problem solving.
- There is a place for ICT and its practical application. The science curriculum needs to be changed to reflect this.
- Many resources in science labs are old and out of date and require upgrading.
- Teachers need to learn how to use new equipment etc. which can take time initially.
- There should be more emphasis on primary science in initial teacher training to give primary teachers a basic body of knowledge and to increase confidence.
- Consideration should be given to joint training in science of primary and secondary teachers both at initial teacher training and in CPD
- CDP should involve active learning
- There is a need to have partnerships with scientists to help teachers keep up to date with current developments.
- The decline of Science Advisers in Local Authorities means that there is no central figure leading developments and supporting schools, especially primary schools.
- Universities and Science Centres could support primary schools more.
- After school clubs are valuable in that the work is more practical and relevant. However, these clubs tend to attract those who already "switched on" to science and so the gap is widened.
- There is a need for more centres/facilities that "switch on" students and teachers to science and enhance the curriculum.
- Lack of time with an overcrowded curriculum has implications for visits to Science Centres etc.
- There is a need for more outreach facilities for Science Centres etc. to visit outlying areas e.g. the Highlands and Islands so that there is equality of provision.

B. Equipment and Accommodation

Accommodation

- Teacher input was seen to be essential for any new design of science accommodation. Good advice is required to help teachers design their labs for their needs. Some recent refurbishments and new builds have suffered due to lack of consultation and the inability to amend contracts in the light of experience.

- Much more money is required to maintain labs and the equipment they contain.

Equipment:

- Many science departments are making do with old and outdated equipment. There is now a feeling that less practical work, and less good practical work, is now being done compared to both the past and to what teachers would like to do. Pupils deserve a good quality, relevant practical experience in science.
- Much of the good equipment, videos etc provided with the introduction Standard Grade is now either worn out or out-of-date but has never been replaced. Poor quality equipment knocks the enthusiasm and motivation of both teachers and pupils. Equipment should not be over complicated but must be fit for purpose, attractive, well maintained and reliable.
- Funds must be available for essential basic apparatus not just large, showy pieces of technology.
- Good quality, modern equipment is needed with a planned programme for its maintenance and replacement. Teachers need to know the level of funding available well in advance to ensure effective spending rather than the "spend it in three weeks or lose it" approach often used at present. Good quality advice, such as that from SSERC, should be readily available to assist teachers purchase equipment. With the demise of local authority science advisers much experience and the means to communicate expertise has been lost. It is feared that a move away from Principal Teachers to Faculty Heads in schools is likely to repeat this mistake at school level.
- Modern ICT is required in science departments. Currently the image of science in schools with respect to ICT compares badly with some other subjects despite science actually being at the leading edge of ICT in industry. School science laboratories should have data projectors, smart boards and modern computers – not just cast-offs from elsewhere in school. Teachers require good CPD to ensure that such resources are used effectively to enhance learning and teaching.
- The decision-making process between government and science teachers is such that funds intended for science are often directed away to other areas. It was felt that many Head Teachers have a poor understanding of the nature and needs of science. With the demise of Science Advisers there is now little influence for science at local authority level.
- A crisis point is being reached with regard to Technician support. Technicians with an appropriate background in science are few and far between. Those who have, or gain, appropriate experience and skills usually then leave schools for "something better".
- Good quality training, appropriate remuneration and a recognised career structure is required for school science technicians. Without technician support the maintenance of equipment will suffer eroding the learning opportunities of pupils. Appropriate support is also required for science and technology in Primary schools.

C. Continuing Professional Development

The groups addressed the question: What are the criteria we should use to evaluate professional development programmes for science education? The main criteria decided were:

- end product – classroom usefulness
- value to personal professional progress
- profile of science content in teachers' experience requires differentiation
- CPD should provide scientific attitudes of challenge, skepticism, enquiry and problem solving, critical thinking and evaluating evidence.

The way forward for CPD in the future ought to address the following recommendations:

- CPD must be seen as a range of activities, not just courses e.g. team teaching, peer observation, learning with and from other staff. There must be time for debriefing and sharing information to maximise the effectiveness of CPD.
- There must be some joint CPD between primary and secondary staff to facilitate good progression and continuity.
- CPD courses vary in quantity and quality around the country, and it may therefore be useful to coordinate these, to ensure that staff in some areas are not disadvantaged.
- CPD must have a definite end product in terms of classroom usefulness
- There must be an element of compulsory science CPD for primary teachers who have been wary of science in the past, and who may previously have opted out of science CPD completely.

4. Science and Technology and Research

Key issues to emerge from these discussions included:

- The science curriculum needs to be pruned if time is to be found to cover additional technological ideas.
- Technology and science departments in schools are separated, often by buildings. If curriculum links are to be established physical, personal and attitudinal barriers will need to be dismantled.
- Open research investigations tend to be more evident in primary schools. The demands of exams dominate the teaching time in secondary schools. There is no incentive to provide pupils with more open, investigative experiences unless they are part of the assessment scheme.
- There are considerable gains to be had from engaging children in thinking and problem-solving group tasks. These are goals which ought to be secured in a new curriculum.
- Stronger links with industry research, perhaps via Setnets and teacher placements, might help to shape student investigations by offering some real contexts.
- In a new, pruned, curriculum time might be made available for extended projects.

Day 1. Session 4

Dr Ken Skeldon, University of Glasgow and IOP PUS Fellow

Dr Skeldon presented excerpts from some of his shows - Beethoven's "Ode to Joy" played on a set of wineglasses filled with water from the "Wonderwaves" show, and a demonstration of the protective properties of Faraday cages for both humans and mobile phones from "Arcs and Sparks".

Day 2. Thursday 6 March.

Science Education Beyond the Classroom.

Day 2, Session 1

Bobby Cerini. Planet Science.

Bobbi Cereni gave an informative presentation on Planet Science which began in September 2002 as a follow-on to Science Year and will continue until July 2003. The idea behind Planet Science is to help young people prepare for a future in which there will be an increase in science and technology. It plans to build on previous success and work in partnership with external organisations.

The brief is to:

- Reach new and non-participating audiences
- Improve quality across the board
- Strengthen existing relationships
- Forge new partnerships
- Leave a legacy
- Inject new energy, risks and ideas

Ian Pearson, BTExact Technologies
A Glimpse of the Future

There is an ongoing convergence of technology with fields such as telecommunications, cognition, artificial intelligence, robotics, computing, sensors, materials, biotechnology and nanotechnology coming together in an opportunity explosion. It is very likely that graduates in the future will not have pursued a single discipline. There is current research in tiny chips linked to various functions, and these will pervade society in gadgets, clothes, skin, packaging etc.

Artificial Intelligence will have a distinct effect on productivity: humans are currently capable of functions far in advance of that of machines, but it is estimated that by around 2010–2015 computers will be able to match human thought. The first version of an optical brain (OB#1) should be in existence by 2010. 100ml of gel can contain 1 trillion neural processors, (20 – 50 times that found in the human brain). Synthetic emotions could be produced by bathing the gel in different wavelengths of light. A significant problem will be that the proportion of knowledge held by humans, which at the moment is very high, will decrease markedly by 2020.

The convergence of IT and biotechnology will lead to convergent products, such as smart materials and smart bacteria. For example, tiny chips could be embedded between skin cells, giving the possibility of "active skin", where "reprogramming" of skin could take place. Sensory recording and playback will allow the development of shared virtual environments. Technology is racing ahead of human understanding. Companies such as BT are not longer doing basic science research, but merely developing technology.

Recommendations:

- Need to invest in more basic science
- Need to enforce responsible technology development, linked to research on the likely impacts.
- We should only develop things we understand and can control, or be very sure of the risks

Y Touring Theatre.

The Y Touring theatre presented an extract form their play 'The Gift' which was based on genetic selection. The play was\aimed at children age 14 plus. In the play a 16 year old boy discovers he has been genetically selected at birth for gender, absence of the gender disorder 'Friedrich's Ataxia' and athleticism. He challenged his father who was a commercial geneticist. In schools the play is followed by a debate with a video on-line back up.

Day 2. Session 2

Dr Simon Gage
Edinburgh International Science Festival, Generation Science Project

Dr Gage described his presentation as having two main themes: "Money and how to get it" and "Doing wonderful things with money".

He hoped that money could be extracted from entrepreneurs in Scotland as well as from existing sources such as the Scottish Executive and the Discovery Channel. He stated it was in the interest of industry to work to ensure young people an enthused by science.

He went on to describe how in the Generation Science Project they are driving to achieve: wonder, excitement and understanding of science. Aspects which too many pupils do not experience.

Science goes to work. Any Questions.

Dr Suzanne King, Director of People Science & Policy Ltd., challenged some the "myths" around the numbers of science and technology students in schools and Higher Education. She pointed out that the UK is 4th in scientific literacy competence and that polls show that the general public is positive about Science, Engineering and Technology (SET).

She outline some issues for the future including:

- Parity for academic and vocational/non-academic qualifications
- Giving young people confidence
- The supply of science teachers
- Continuing Professional Development of teachers
- Careers advice
- Science for Citizenship

Ann Van Gysel of the Flanders Interuniversity Institute for Biotechnology talked about a project she is involved in working with 14+ children in Belgium. Their aim is to link teachers and pupils with scientists and to get pupils and teachers out of the classroom and scientists into the classroom. They want to bring science into the lives of pupils and to get them excited about science. They also work a lot with teachers, advising them and working together on projects. Biotechnology touches on many issues in people's lives and they try to incorporate these in their projects. One such project linked students with farmers to look at genetically modified crops so that students could make informed opinions. Use of the internet is involved in projects which are funded by the EU. It is hoped that projects of this type will be started up in other EU countries.

Dr Ray Peacock talked of the aims of SETNET, in particular that of having more people with a technology background working in schools. He saw there was a need to ensure that every child had an entitlement to have had experiences in science and technology in school.

Tony Sherbourne of Sheffield Hallam University discussed the future of science education in terms of the "system" versus the vision for science education and the fact that the "system" at present is based on what was needed after the Industrial Revolution. We need to take risks to move from the "system" and look at other ways of delivering beyond the curriculum. Money is available for those with initiative. They need to find the courage to "live the dream".

Day 2, Session 3

Heather Reid, Weather forecaster

Heather Reid, weather broadcaster, took us on a tour of cold, warm and occluded fronts, Coriolis forces and convection cells. She explained that our weather is driven by two main elements, the Sun's energy and the rotation of the Earth. Heather shared some of the secrets of her 2 minute 40 seconds of fame on the BBC each evening and in so doing she presented an important role model for anyone with an interest in communicating science.

Science Goes to Work – Any Answers?

The conference divided into round table working groups to consider issues relating to science education beyond the classroom. A summary of the key issues is given here.

'Enrichment' of the type represented by STEM, Industry and Science Centre projects was seen as important and it was thought that experiences such as these should be a mandatory part of the curriculum available to all children across Scotland. Coverage at present is patchy with rural areas missing out on the more urban-based provision. The quality of provision is variable with poor communication being the needs of the school and the perception of the provider as the major issue. The demands of a crowded curriculum appear to inhibit teachers making use of STEM-type support. This is particularly true in years three and four. However, it was thought that if the content of the curriculum were cut to make room for such activities there would be pressure on teachers to spend time covering less content but providing a richer experience for learners. Currently teachers will not risk the examination chances of pupils by doing activities outwith the curriculum.

There was a preference for Industrial links to be brought into the school arena with trained presenters offering imaginative experiences for children tailored to their interests and learning needs. However, the opportunity to experience aspects of science beyond the school was also seen as desirable feature of a good education. With curriculum space available and an entitlement to enrich all pupils through such experiences, there was a feeling that out of school learning might take on a new dimension. It might even become integrated into a learning scheme for all pupils rather than a bolt-on appendage for some.

A good STEM activity was felt to need to be motivational through an interesting / fun element but should also be interactive. Learners appreciate having a chance to contribute ideas and opinions and to ask questions. Hence such activities ought to make use of best practice in communication and engagement skills. Learners want to be heard and to have a place for their own voices.

All participants recognised the value of science / Industry links in helping students to see the relevance of their studies and to help them to contextualise what can seem to be a very abstract subject. Such links also demonstrate the need for a multi-disciplinary approach and the integration of science and technology, and to let students find out about current scientific research.

In summary we need:

- to create curriculum space for STEM-type activities
- to build in such experiences as an entitlement for all children
- to relate such activities directly to the local needs of a school and where possible to relate them to the curriculum.
- better design and co-ordination of STEM-type activities.
- better communication of available STEM activities to all schools
- equitable provision of STEM-type activities across the country
- Perhaps an "Industry Link Teacher" could be identified in each school.
- Time should be allocated for teachers to link with industry.
- Such links could be made a compulsory part of a Chartered Teacher Programme.
- Careers Scotland should set up a current database of links to research establishments.
- Exam-led teaching still dominates and stifles innovation – the exam-driven curriculum must change
- Engineering need to find a place in schools to work alongside teachers.

During this session a number of young people voiced strong opinion about school science and their futures. Particular points raised were:

- There was not an image of science as nerdy or geeky among these students.
- A career in 'science' was seen as too broad a category and not helpful. Young people are interested in specific careers where science plays a part. They need information on such careers.
- School education is seen as a set of unrelated 'subjects'. There needs to be work done to break down subject barriers and show the relationship between areas of study.
- Much of the equipment in science labs is old, broken and depressing. Money is needed to improve in all areas from broken blackboards to non-functioning power sockets.
- Opportunities for longer, extended investigative work would be valued, perhaps making use of industrial links and contexts.

Day 2, Session 4

Dr Robin Hoyle, Glasgow Science Centre

This last session of the day opened with a science spectacular. Dr Hoyle presented a sequence of exciting and engaging science demonstrations which are bound to capture the imagination of young people. Glasgow Science Centre has a programme of outreach activities which takes science on the road to remote schools and communities.

Dr Ken Thomson, Falkirk College

Ken Thomson presented a vision of his college in 2020. He described a 'vocational loop' model of partnership, design and development, delivery and assessment which he saw as a defining feature of the work in a college of Further Education. His vision included partnerships across the world via a 'Transatlantic Training Alliance', ethical discourse as a component of all courses and staff being trained and updated by industrial partners. In the new Industrial Assessment Centre videotaped evidence will be used to assess performance. Courses will be delivered by 'flexible blended learning' and instant feedback from real time assessment will steer students. Ken surprised the audience with his closing remarks. He explained that all the features outlined in his presentation were already in place at Falkirk College.

Day 3. Friday 7 March

Science and the Citizen

Professor Graham Durant launched this final day by presenting some scenarios in which science and the citizen collide amid a tangle of moral and ethical considerations. The arguments surrounding heart transplants, animals as organ donors and genetic engineering were presented through the medium of animation.

Professor Wilson Sibbett, Scottish Science Advisory Council (SSAC)
Shaping the Future of Science in Scotland

Professor Sibbett began by outlining the nature and role of the SSAC. It is intended it provide independent advice to ministers on strategic issues related to science in Scotland of which science education is a key part.

Prof. Sibbett indicated that in his vision of Scottish science in 2020 involves:

- inspirational science education with better equipment and better use of ICT
- global leadership in key scientific areas building on existing strengths as well as developing in areas in which we should be strong
- a knowledge based economy where Scotland had moved up the value chain
- a greater scientific awareness across society, science is an integral part of our culture

Within that he sees science education that:

- is effective, challenging and engaging
- harnesses pupils/students fascinations and curiosity
- engages all age ranges in society
- produces more role models
- inspires wealth creation and enhances quality of life

Science education must therefore be enhanced by:

- improving the curriculum
- smoothing the transition between primary and secondary
- good continuing professional development for teachers
- delivering the next generation of high quality science and technology teachers

He highlighted some of the rewards science, engineering and technology offers:

- interesting and varied careers
- interaction in a world-wide arena
- good salaries
- opportunities to influence policy makers
- entrepreneurship and wealth
- opportunities to win Nobel prizes

Day 3, Session 1

Sir Kenneth Calman

Sir Kenneth used a series of engaging cartoons to establish his key issue – how to get science issues on the school and public agenda. He raised questions about which issues ought to be brought into the public domain and how best to achieve such awareness. A key question we ought to ask when considering ethical issues in science and technology, he suggested, was not 'could this be done' but 'should this be done'. He called for a greater awareness of the balance between risk, benefit and uncertainty in the public domain. For Sir Kenneth, the science was relatively easy. The moral questions surrounding the science was the harder issue for us to grapple with.

Prof Robin Millar and Prof Jonathan Osborne. Breaking the Mould.
Robin Millar presented an outline of an innovative course, 'Science for Public Understanding', being piloted in England. This one year, post 16, course was designed for students with an interest in science but who might not wish to follow separate sciences. The course was founded on two main elements: science explanations – the big issues and ideas in science, and Ideas about Science – the way science works. The course is within a suite of one year courses called AS courses and engages students in modern ways of learning. A key outcome of the course for students is a confidence to engage in discussion about science issues which might find themselves in the public domain.

Professor Osborne presented an evaluation of the AS course carried out by a team at King's College, London. Key messages emerging from the evaluation showed that there was a need for teachers to adapt their teaching styles to help students engage in small group discussion and presentations. It is evident that teachers need support in their understanding of how science works. Few teachers appeared to have any background in the philosophy of science. There was however evidence of high levels of student engagement in the course and that the course is attractive to both male and female students alike.

Day 3, Session 2

Any Questions panel session

The panel for this session consisted of Professor Robin Millar, Sir Kenneth Calman, Prof. Aubrey Manning and Donald Bruce. The broadcaster Sally Magnusson held the Chair. Issues raised and discussed included:

- the purpose of school science education
- the prospect of science boundaries being dismantled
- the over-reliance of the education system on examinations.
- The fitness for purpose of practical work
- The relationship between competence in science and mathematical skills.
- The prospect of integrating Public Understanding of Science courses within the present assessment scheme.
- The potential for liaison between science and humanities departments.

Day 3, Session 3
Science and the citizen – Any Answers?

The conference divided for a series of round table discussion groups.

Uncertainty and Risk

This group was asked to consider 5 reasons why it is important to understand the concept of risk, and 5 effective methods of conveying the concept.

Importance of understanding risk:

- Issues which frighten people can be perceived as high-risk, due to lack of information or misinformation.
- People are bombarded with information about risk, particularly from the media, not all of which has a sound basis.
- People need to be able to compare the risk from different sources, to make informed decisions.
- Decision-making with regard to personal health can be influenced by an understanding of risk

Effective methods

- Use headlines; circulate articles on risk; consider some frivolous and some important articles to decide whether the media is portraying real or perceived risk
- Introduce all pupils to the concept of risk – could be done in Social Education or in a compulsory course on the understanding of scientific issues.
- Use contexts which are relevant to everyday life.
- Support teachers in presenting the concepts of risk – CPD and resources needed.
- Introduce the concept of risk at a very young age, with appropriate contexts

Ways and Means

2 groups were asked to present techniques for introducing scientific issues to the curriculum, and to consider the advantages and disadvantages of each.

Technique	**Advantage**	**Disadvantage**
Debate	Most pupils can contribute; challenges pupils.	Can become unfocussed; tends to be dominated by a few.
Video	Useful for introducing issues; shows things which cannot be experienced in school.	Passive; become out-of-date very quickly.
Small group work	Good confidence builder; concentrates the mind; allows other perspectives to be considered; easier for pupils to voice opinion in a small group.	Can be dominated by an individual; one person could do all the work; lack of focus.
Role play	Introduces broader experience and attitudes; stimulating and creative; powerful when dealing with human issues.	Only suits some pupils; may be uncomfortable for some.
Pupil records and presentations	Pupils are centre stage; good opportunity to use external resources; develops transferable skills.	Time consuming; needs a lot of preparation; pupils can miss essential points.
Case studies	Used in Social Education and Social Science, so pupils familiar with techniques.	Presentation can be dull.
Mind maps	Creative; useful skill for pupils to develop; allows pupils to see "big picture".	Time-consuming; can be unfocussed.
Worksheets	Provides a framework or structure; may suit quicker pupils.	Restricts opportunity for open-ended work.
Newspaper cuttings / media reports	Can be used as independent homework exercise; promotes interdisciplinary nature of science; facilitates class discussion.	
Cross-curricular work	Pupils can use science topics as a theme in work for other subjects eg. English essays.	Difficult to organise within school.
Use visiting speakers, drama groups etc.	Allows pupils to see a different perspective; presents science in a new context.	Often expensive; external speakers do not always communicate well with school pupils.
New science courses	New courses in S3/4 or S5 would allow issues to be more central to courses.	Would required major curricular review; would require new methods of assessment to be developed.

Issues in the Classroom

- Pupils would welcome the opportunity to respond to issues, rather than simply reiterating facts.
- Increasing the range of courses on offer in S3/4 would allow the introduction of issues (eg. Psychology).
- Pupils are better motivated if they are informed on issues which they feel they can change.
- Pupils should be encouraged to make their views known, and to discuss issues, knowing that their views will be valued. "Wrong answers" given by pupils should present the opportunity for further discussion.

Decision-making

How do we develop the process of decision-making in pupils, and how do we test it?

Development:

- Brain-storming
- Question / answer sessions
- Hypotheses
- Discussion groups
- Information gathering – websites, library, CD-Rom resources etc.
- Demonstrations / practical experiments / investigations
- Encourage the consideration of implications / relevance of results to form an informed conclusion or decision
- Defining and refining the question
- Selecting required information

Testing

- Written or practical assessments
- Presentations by pupils
- Role play
- Class debate
- Suggesting problem-solving situations similar to a situation previously studied
- Evaluation
- Replication
- Exposure to unfamiliar using familiar ideas – lateral thinking

Key Issues emerging from the discussions

- The fact that issues are not assessed in science courses leads to them being neglected in teaching. Both teachers and pupils see them as incidental to courses, rather than an integral part of them.
- On the whole, teachers are not familiar with teaching styles which are more appropriate to the presentation of issues. CPD is necessary if issues are to be embedded in the curriculum.
- There is a strong argument for a course on the understanding of scientific issues. This could be optional, or it could be a core course for all pupils, with other (more traditional) courses being optional.
- Issues should be presented in ways which emphasise the integral nature of science. Separate science departments can be a barrier to the perception of science as an interdisciplinary activity.

Stuart Robertson
The national grid for learning

Stuart Robinson posed three questions:

- can ICT prepare children for the future?
- will ICT be evolutionary or revolutionary?
- why ICT?

In addressing these questions Mr Robertson suggested that learning skills can be improved via ICT and indeed pedagogy can be changed through the skilled use of ICT. He noted the large scale investment in Scotland to date on new technologies for learning and also noted the increase in teacher confidence in the use of ICT. He argued that an enrichment in ICT provides learners with skills for lifelong learning. The future would see continuing investment in ICT, including broadband connections linking schools and the parallel investment in CPD for teachers.

Tim Smit, The Eden Project and its Approach to a Changing World.

Tim Smit described how some defunct china clay pits had been transformed by a team of workers who he described as 'ordinary people building an extraordinary project'. His philosophy, which drove the project to fruition, was encapsulated by:

'Work like you don't need the money,
Love like you've never been hurt,
Dance like there is nobody watching,
Sing like there is nobody listening,
Live like it is heaven on earth.'

His goal was to make sure that the project was sustainable and to show that without science the world was not civilised. For Tim Smit, science allowed people to make decisions and to realise their full potential.