

scottish **science**
advisory committee



WHY SCIENCE EDUCATION MATTERS:
Supporting and Improving Science Education in Scottish Schools

Scottish Science Advisory Committee | November 2003



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The Scottish Science Advisory Committee

The Scottish Science Advisory Committee (SSAC) is an independent Committee, established under the auspices of the Royal Society of Edinburgh with funding from the Scottish Executive, to provide advice to Scottish Ministers on science strategy, science priorities and science policy.

Further details about the SSAC can be found on its website: www.scottishscience.org.uk

The SSAC Vision for Science in Scotland

The Scottish Science Advisory Committee's vision for science in Scotland is one where all aspects of science activity are connected optimally, with international excellence being a targeted and achievable goal. Scotland already has a number of internationally recognised strengths, but to deliver the best outputs from these activities requires the investment of significant effort and resource to harvest the added value that better connectivity can deliver. There is evidence of a willingness of the science-based communities to work together, but the SSAC's vision is that a more comprehensive co-ordination can be put in place to ensure that Scotland is more able to realise its full potential in all sectors of its scientific endeavours.



summary of recommendations

Scotland has a distinctive education tradition and a culture where education is valued. The Scottish Science Advisory Committee (SSAC) believes however that there is an urgent need to improve science education in Scottish schools and that this must be regarded as a matter of high priority. Provision of a modern and relevant science education is an underpinning factor in the development of Scotland's knowledge economy, educational systems and society as a whole. The underlying reasons for the decline in the number of school and university students studying science that has been evident in recent years must be addressed, otherwise this decline will have serious consequences in the future.

Stimulating and engaging science education is a key component in developing, within Scottish society, a more robust confidence and competence in scientific issues. It is crucial that more young people become excited by science and that a larger proportion of these choose to continue to study science at school and beyond. This also requires the support and understanding of teachers, careers advisers, parents, the media, politicians, and the general public. It is also true that a scientifically informed and aware public will be better able to make important choices about the applications and the benefits of scientific and technological advances. To achieve these aims Scotland must improve and enhance its provision of science education at all levels, starting at primary school or even pre-school levels.



recommendations

the science curriculum

- The Scottish Executive Education Department (SEED) and the examination authorities should, as a matter of urgency, establish a curriculum review group with the specific remit of producing a prioritised, less crowded, flexible set of curricula for all levels of science courses.
- A course on *Science for Citizenship*, analogous to the one-year AS Level Course now available in England, should be introduced for all students, but specifically targeted at those not progressing to science higher.
- All science courses should include some coverage of relevant ethical, environmental and social issues.
- All primary schools should have a dedicated science room, or in smaller schools dedicated science space, where children can be taken out of their normal classroom environment to engage in science activities.
- All primary schools should either have an appropriate number of teachers with specialist training to teach science at primary level or there should be local clustering of schools. In this latter instance, science teachers from neighbouring secondary schools should be available to advise and assist with science classes in the primary schools.
- In each district there should be small teams of science technicians, based in secondary schools and linked to local colleges and universities, who would be available to provide technical support to the primary schools.
- Continuing professional development (CPD) should be used to increase the number of primary teachers with specialist training to teach science. For example, the two-year ‘twilight’ (evening) course leading to a diploma qualification, currently offered by Strathclyde University’s Education Faculty, represents an excellent initiative.
- SEED should provide resources to sustain the *Improving Science Education 5-14 Programme* in the longer term.

improving science infrastructure in schools

- A rolling investment programme is required to ensure that all schools have modern well-equipped laboratories.
- Technical support in schools must be strengthened so that the pupils can have the experience and stimulation of “hands-on” practical work.
- All secondary schools should have at least one dedicated science technician. Such staff members should be seen as an integral part of the science provision, having access to appropriate CPD and career enhancement opportunities.

the teaching of technology and technical skills

- Enhanced support should be given to Further Education (FE) colleges to deliver attractive technology courses, coupled with incentives for students to take the courses.
- Schools and colleges should be encouraged to provide the appropriate training packages for students to allow them to progress to technically skilled jobs.

co-ordinating and connecting science education activities across scotland

- The Scottish Higher Education Funding Council (SHEFC) and SEED should together provide financial support for the establishment of a Scottish Science Education Network (the Institute for Science Education in Scotland (ISES)).
- SEED should ensure that earmarked funds are available to schools to fund CPD programmes for science teachers. A significant part of this CPD should be in science.
- The Scottish Executive should find a means to provide financial support to ensure the sustainability of the Scottish Science Centres as a network which fulfils a cultural and educational role. This would be similar to the philosophy behind its support of museums and art galleries.
- CPD should be introduced for school careers advisers to improve their awareness of the advantages of studying science at school and beyond in terms of the variety of career opportunities that are on offer to science graduates.

recruiting and supporting the next generation of high quality science teachers

- A reward scheme, for example writing off student debt and/or an enhanced salary package, should be introduced to attract able science graduates into teaching.
- Funding should be made available for individuals seeking a career change from business or industry into teaching, to pursue postgraduate teaching qualifications.
- The present regulations that prevent science teachers in secondary schools teaching in primary schools and teaching outside their speciality subjects need to be reviewed and constructively relaxed.
- Some younger science teachers should be recruited now, ahead of the high predicted number of retirements, to ensure continuity in science teaching and to avoid staffing difficulties in the future.

research in science education

- Scotland must have links through the Institute for Science Education in Scotland (ISES) to the new National Science Learning Centre in England.
- The Research Policy and Strategy Directorate at SHEFC should work with SEED to make resources available for research in science education.


why science education matters:

supporting and improving science education in scottish schools

Innovative science and engineering are the drivers for new technology, new businesses and improved quality of life. Scotland aspires, within the next decade, to become a world leading technology-based economy with an enhanced and sustainable quality of life. This will require both an excellent supply of young scientists and engineers and a population that better understands and appreciates science. A competitive knowledge-based economy requires a robust science education as a foundation. Also, a scientifically informed and aware public will be better able to make the important choices about the applications of science and the benefits of scientific and technological advances to all sections of society.

introduction

- 1 At its first meeting in 2002, the Scottish Science Advisory Committee (SSAC) accepted that, given its broad remit, there was a need to establish a number of working groups to develop and take forward distinct elements of its activities.
- 2 The three priority areas that were highlighted from these initial discussions led to the formation of three working groups:
 - **Science Education;**
 - **The Science Base – Mechanisms for Excellence;** and
 - **Science in Society.**
- 3 The SSAC agreed that improving science education in Scottish schools was a matter of the highest priority and this paper is the result of the deliberations of the members of the Science Education Working Group. The SSAC will shortly produce its first comprehensive overview of science in Scotland, *Science Matters: Making the Right Connections for Scotland*, together with a further paper, *Investing in Scientific Talent*, that will focus on attracting, developing and retaining scientists in Scotland.
- 4 While the SSAC recognised some evident strength in relation to school science education in Scotland, such as well-qualified science teachers, it also identified areas where investment and strengthening are urgently required. Not least is the need to reverse the decline in numbers of pupils and students studying science subjects at school, with the knock-on effects for further education (FE) colleges, higher education institutions (HEIs) and technology-dependent businesses and industries.

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- 5** The SSAC has adopted a broad and inclusive definition of science in relation to its interests and remit. It interprets its science remit to be one that encompasses the life, physical, mathematical, computational, medical and veterinary sciences through to engineering and technology. In relation to school science it recognises, however, that the scope of science is rather more limited.
- 6** The SSAC believes that there must be two objectives for science education in Scotland, which are:
- **to provide an excellent supply of young engineers, scientists and trades personnel;** and
 - **to raise and extend the general level of knowledge, understanding and awareness of science and technology in the population as a whole.**
- 7** The areas, identified by the SSAC, that require urgent attention include:
- **The science curriculum;**
 - **Improving the image of school science by a greater investment in infrastructure;**
 - **The teaching of technology and technical skills;**
 - **Co-ordinating and connecting science education activities across Scotland;**
 - **Recruiting and supporting the next generation of high-quality science teachers and technicians;** and
 - **Research in science education.**
- 8** The recommendations in this paper call for:
- **A programme of curriculum change;**
 - **Investment in infrastructure;**
 - **Recognition of the importance of technology and technical skills;**
 - **Co-ordination of support activities;**
 - **Recognition of a need to ensure a cohort of high-quality science teachers for the future:** and
 - **A programme of research in science education.**

These recommendations are intended to take Scotland into the forefront of science education.

the need for science and engineering graduates to drive the knowledge economy

- 9 Innovative science and engineering are the drivers for new technology, new businesses and improved quality of life.** Scotland aspires, within the next decade, to become a world leading technology-based economy with an enhanced and sustainable quality of life. The knowledge economy requires both a supply of excellent specialist scientists and engineers who will pursue careers in their professional areas and a supply of scientifically informed individuals to take leading positions in the business and commercial sectors as well as in government and its agencies.
- 10 The proportion of school pupils in Scotland studying chemistry, physics and biology at higher grade shows a steady decline between 1993/94 and 2000/01 (Table 1).** The reasons behind this are complex, but need to be understood in an effort to reverse the decline. It may reflect, in part, the attitudes of parents, teachers, relatives and friends, which are known to have a major influence on school pupils who are considering subject and career choices. **In recent years public confidence in science has decreased due to events such as the BSE and Foot and Mouth crises.** Additionally many people have become uncomfortable with the speed at which science is advancing in areas such as biotechnology and nanotechnology, and are increasingly unaware of the huge opportunities and “up-side” presented by such developments. **Other factors may include the belief that science is difficult, is losing relevance to a modern society and offers little reward in the longer term. The lack of modern, state-of-the-art teaching facilities further exacerbates this situation.**

Table 1:
the proportion of school pupils in scotland (as percentage of school roll) taking higher sciences

Subject	93 – 94	94 – 95	95 – 96	96 – 97	97 – 98	98 – 99	99 – 00	00 – 01
Chemistry	10.8	10.3	10.3	9.7	9.4	9.3	9.5	9.2
Physics	10.4	10	9.9	9.1	9.3	9	8.7	9
Biology	7.6	7.3	7.4	6.9	6.9	7.0	6.9	6.6

Source: The Royal Society of Chemistry, 2002 *Science and the Parliament 2002 Briefing*

- 11** There is a need to improve the awareness of the career opportunities for scientists, and of the value of a scientific degree as a pathway to a good career in business or industry. The fact that science graduates are particularly valued by employers¹ for their numeracy, their ability to access and organise large amounts of data, and because they have been taught to reason and to make evidence based decisions is not sufficiently well recognised.
- 12** This is all part of the general need to rebuild public confidence in science. It is particularly important that careers and guidance teachers, as well as parents and pupils, have access to information about the importance and value of studying science at university and beyond. A Smart Successful Scotland² will depend on a skilled science and engineering work force, scientifically informed managers and administrators as well as a scientifically informed public.

the science curriculum

- 13** The present science curriculum both at standard and higher grade is too content-dominated, with virtually no scope for individual teachers to include topical or innovative material to inspire their pupils. All too often teachers and pupils struggle to get through the crowded syllabus because their activities are dominated by an assessment-driven agenda. The emphasis on learning facts to pass assessments leaves insufficient time to develop scientific reasoning and problem-solving skills.
- 14** Science is often perceived as difficult and boring. Its relevance to modern society in relation to aspects of the quality of life, the development of the economy and the sustainability of the environment tend not to be well explained. Flexibility in the curriculum is essential to allow such links to be made. There is also the perception that only the most able will find careers in science.
- 15** Two areas identified by the SSAC as requiring urgent attention are, primary school science and the primary-secondary school interface. It is vital to improve the experience that primary school pupils have of science and to make sure that their interest in science is sustained and developed across the primary-secondary transition. This will help to ensure that they will choose to study science subjects at standard and higher grade and continue with these studies at college or university.

¹ SET for success: The supply of people with science, technology, engineering and mathematics skills, The Report of Sir Gareth Robert's Review, April 2002

² A Smart, Successful Scotland: Ambitions for the Enterprise Networks, Scottish Executive, 2001

- 16 The lack of science specialists in primary schools, coupled with the absence of science infrastructure in virtually all primary schools, makes it difficult to teach science at this level.** The SSAC supports strongly the enhancement of facilities and staffing for the delivery of science teaching in primary schools. It welcomes the development of the *Improving Science Education 5-14 Programme*³, which provides a good framework for teaching across the biological, physical and environmental sciences for the age range from P1 to S2. However more interactions between secondary schools and their primary feeder schools are needed to ensure that the full benefit is obtained from the 5-14 programme. Given that subject choices are made at S2, it is crucial that pupils have had a positive experience of science by this stage.
- 17 While the boundaries between the science specialities are becoming progressively blurred, the SSAC recognises the importance of learning the underpinning principles of the core science subject areas of physics, chemistry and biology.** It would wish to discourage any pre-S6 uptake of specialist higher grades in subjects such as psychology, biotechnology and human biology. Currently most pupils take only one science course at standard grade; the case should be considered for introducing some new double science courses, for example chemistry and biology, chemistry and physics, that could feed both general and specialist higher grades.
- 18** Within the 5-14 curriculum many issues-based science topics other than the core sciences of physics, chemistry and biology (e.g. Earth and Space) are introduced, capturing enthusiasm for science and demonstrating its relevance to current issues. The earth science/physical geography elements also provide a bridge between the physical and the social sciences. This integrated approach from age 5 to age 14 needs to have some analogue in the post-14 curriculum. Support must be put in place for teachers delivering in these areas in both the 5-14 and post-14 curricula.

the importance of ethical issues

- 19** Many new and rapidly developing areas of science, such as stem cell technology and nanotechnology, raise fundamental ethical and social questions and it is essential for all pupils to have the opportunity to study and debate the wider ethical and moral issues relating to science. For students studying science at higher grade this material should be included in their courses. For students not progressing to science at higher grade, the SSAC favours the introduction of a course on **Science for Citizenship** analogous to the one-year AS level course now available in England. This course aims to broaden the curriculum by giving arts and humanities, as well as science, students the opportunity to reflect on scientific issues in a wider context than in a science course. The SSAC favours science training alongside an exposure to the arts and humanities so that Scottish education remains broadly based. The AS Course on *Science for Public Understanding*⁴ encourages a wide range of skills such as debating and independent research. It also encourages students to evaluate information in order to make informed decisions about contemporary issues related to, and underpinned by science, thereby allowing them to reflect on the impacts of science on society.

³ Improving Science Education 5-14, www.ise5-14.org.uk/Prim3/Head2.HTM

⁴ www.scpub.org/home/index.asp

improving science infrastructure in schools

- 20** There is a need for investment in secondary school science laboratories, especially in the quality of the accommodation and the equipment (including the provision of computers). It is also vital to provide more dedicated technical support so that better, more challenging practical work can be delivered to the pupils. Science subjects must be recognised by pupils as high priority subjects that are taught in modern, well-equipped laboratories by enthusiastic teachers, supported by specialist science technicians. **The current major investments in relation to building new schools across Scotland opens up opportunities to introduce design concepts that enhance science education as well as the more general learning experience.**
- 21** Primary schools rarely have purpose-built accommodation for teaching science and they generally lack equipment and technical support.

the teaching of technology and technical skills

- 22** A modern economy needs a large cohort of highly trained technologists, technicians and trades personnel (for example plumbers, carpenters, electricians, metal workers) with the relevant skills to follow these careers. It is already recognised that the supply of such trained individuals is in decline⁵ in Scotland. The profiles of careers in these areas must be enhanced if this trend is to be reversed. Attractive science and technology courses should be made available at the school level and subsequently linked to courses at FE Colleges to enable students to enter these important fields.

co-ordinating and connecting science education activities across scotland

- 23** There are many organisations throughout Scotland attempting to provide good science education experiences for school pupils. These include the SET Points⁶ with the associated *Scientist and Engineers Ambassadors Scheme* (SEAS), the Scottish science and discovery centres, science festivals, the British Association, the Generation Science Project⁷ with its Scottish Schools Touring Programme and Careers Scotland which co-ordinates special programmes such as the Scottish Space School Foundation⁸.
- 24** There are also many professional organisations and learned societies such as the Royal Society of Chemistry, the Institute of Biology and the Biosciences Federation, the Institute of Physics, the Royal Society of Edinburgh and many others which organise events both for pupils and teachers. Additionally, a number of Scotland's FE Colleges, Universities and research institutes have a range of science outreach activities.

⁵ For example see: *Construction Skills Action Plan for Glasgow: 2003 – 2008*, Scottish Enterprise Glasgow

⁶ www.setpointscotland.org.uk/

⁷ The Generation Science Club is a network of leading Scottish businessmen and women who want to see more inspirational science teaching as the basis for Scotland's future inventors and technology entrepreneurs. The members help fund the Edinburgh Science Festival's schools touring programme taking science shows around Scotland so that every primary school child is introduced to the world of science.

⁸ www.careers-scotland.org.uk/careersscotland/web/site/LearningandGuidance/EIE/spaceschool.asp

- 25 There is too little co-ordination of science education activities across Scotland.** Encouraging connections between the many organisations which aim to provide good science education to share knowledge and experience can serve to maximise the benefits. This improved communication will be best achieved by establishing a formal Scotland-wide network.
- 26** These science education activities also need to be co-ordinated with the science education activities of the Local Authorities and the Scottish Executive Education Department (SEED). In particular there needs to be local clustering involving primary and secondary schools, industry, SET Points, science centres, colleges, research institutes and universities.

recruiting and supporting the next generation of high quality science teachers

- 27** For many years the supply of science teachers in Scotland has been adequate. However, this does not apply to even the near-term future because it is predicted that half of the entire teaching profession in Scotland is due to retire in the next decade. Figure 1 shows the trend in the age profile of teachers in Scottish schools between 1998 and 2000. The SSAC is particularly concerned about the age structure of the science teacher cohort, where one third of all science teachers are over 50 years old and over half of all science teachers are over 45 years⁹. **Within a few years it is predicted that there will be a significant shortage of teachers in the physical sciences, especially in physics and soon afterwards in chemistry.** Table 2 provides an indication of the number of teachers required over the period 2001/02 – 2007/08 in Scotland. Physics has been designated as a top priority subject, by the Scottish Executive in its *Supply of Teachers Report*, with chemistry being designated as a priority subject¹⁰. The SSAC believes that there has been insufficient effort to recruit younger teachers ahead of the impending rush of retirements.

Table 2:
estimate of the number of newly qualified teachers required over the period 2001/02 to 2007/08

Subject	Number of newly qualified teachers required over the period 2001/02 – 2007/08
Chemistry	357
Physics	210
Biology	127

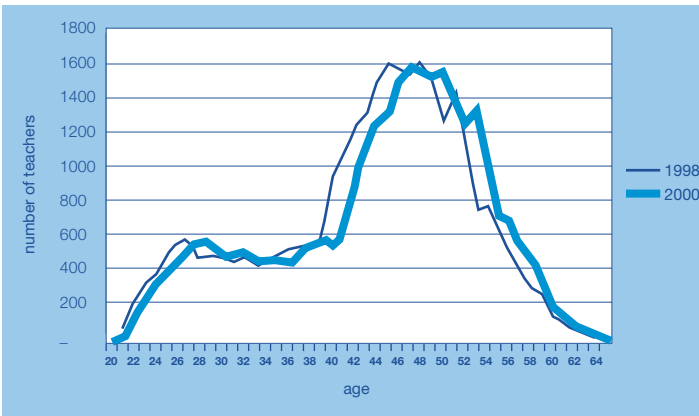
Source: *The Supply of Teachers Report Edition 2*, Scottish Executive, June 2001

⁹ *Teacher Statistics for Scotland*, Scottish Executive, 2001

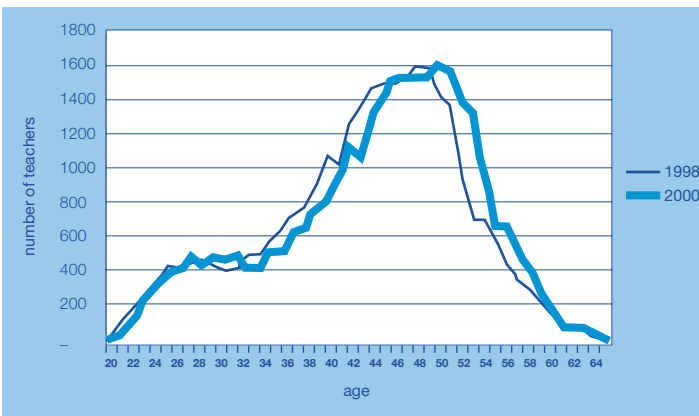
¹⁰ *Supply of Teachers Report Edition 2*, Scottish Executive, 2001

Figure 1:
age profile of school teachers in scotland: estimated 2000 profile compared with the 1998 teacher census

pre-school, primary and primary special



secondary and secondary special



Source: Results of Teacher Workforce Planning for 2003/04, Scottish Executive

- 28** The age profile of the present generation of science teachers indicates that the majority completed their University studies more than 20 years ago. Given the rapid advancements in many areas of science, there is a recognised need for continuing professional development (CPD). While there are some good summer schools and 'twilight' (evening) courses available, the provision and the uptake is variable.
Every science teacher must have the opportunity to access relevant CPD.
- 29** The demographic problems relating to science teachers are reflected in the age profiles of school technicians. The SSAC contends that these specialist support staff are vital in providing high quality science education. The SSAC recognises that work is currently going on, south of the border, in this area¹¹. Whilst the efforts of the Association for Science Education (ASE), the Royal Society and the Department for Education and Skills (DfES) are welcomed in this regard, Scotland's school technician services have their own distinctive character. **SEED and the Local Authority Education Departments need to be proactive in this area and recruit younger technicians and offer them attractive career paths and development opportunities as specialist science technicians.**
- 30** **There are very few primary teachers with science backgrounds** and more must be done to encourage science graduates to consider a career in primary teaching and to provide existing primary teachers with training in science. Salary differentials as reward incentives should form part of this consideration.

research in science education

- 31** **The SSAC is concerned that there is very little research activity in Scotland in the field of science education**, but welcomes the recent SEED/ Scottish Higher Education Funding Council (SHEFC) initiative¹² designed to develop high quality educational research capacity in Scotland. This lack of research activity is hampering the development of research-informed policy for science education. In this connection the SSAC strongly recommends that Scotland should join the Wellcome Trust – Department for Education and Skills (DfES) Initiative in England and establish a Scottish spoke for the proposed UK Hub – the National Centre for Excellence in Science Teaching¹³.

¹¹ *Supporting success: science technicians in schools and colleges*, The Royal Society and the Association for Science Education, 2002

¹² Applied educational research: joint funding scheme, SHEFC and Scottish Executive Education Department, www.shefc.ac.uk

¹³ www.sciencelearningcentres.org.uk/

specific recommendations

the science curriculum

- 32 The present very crowded curriculum, at all levels, must be prioritised and reduced.** There should also be a modification of the present assessment system with the aim of placing less emphasis on work sheets and final examinations and more emphasis on in-course assessment and problem solving. The universities need to be consulted about these changes, to ensure that pupils are not disadvantaged with respect to University admission. It will also be important to provide attractive courses for those pupils seeking technical rather than academic qualifications.
- **SEED and the examination authorities should, as a matter of urgency, establish a curriculum review group with the specific remit of producing a prioritised, less crowded, flexible set of curricula for all levels of science courses.**
 - **A course on *Science for Citizenship*, analogous to the one-year AS Level Course now available in England, should be introduced for all students, but specifically targeted at those not progressing to science higher.**
 - **All science courses should include some coverage of relevant ethical, environmental and social issues.**
- 33** Primary school science and the primary - secondary school transition were also identified as very high priority areas for change. Effective mechanisms are needed to bring science specialists into primary schools to assist the teachers. In the longer term more specialist primary teachers with science backgrounds are needed. It would be very beneficial, as has recently been piloted in Edinburgh, for all primary schools to have a science room, or at least dedicated science space, where simple practical work can be carried out with technical support. A small number of versatile science technicians supporting primary school teachers and science activities would also make a huge difference to science teaching and learning outcomes.
- 34** While it is probably not necessary to have a very precisely defined syllabus for primary school science, it is desirable to identify a range of topics covering the full range of science from which teachers can select. The SSAC therefore welcomes the SEED initiative, the *Improving Science Education 5 -14 Programme*. This provides very useful exemplar material for primary and early secondary teachers. However it is vital to put in place the resources to ensure that this programme is continuously updated in the future. It is also very important to have a good bridge between primary school science and secondary school science. At present the syllabus for S1 and S2 science is poorly defined. The Science 5 -14 Programme provides the means to achieve a good link between primary and secondary science by continuing with the flexible, wide-ranging course recommended for primary science in S1 and S2. From S3 onwards, pupils should be presented with the opportunity to choose particular areas of science for further study or to continue to standard grade with good practical-based technology courses.

- All primary schools should have a dedicated science room, or in smaller schools dedicated science space, where children can be taken out of their normal classroom environment to engage in science activities.
- All primary schools should either have an appropriate number of teachers with specialist training to teach science at primary level or there should be local clustering of schools. In this latter instance, science teachers from neighbouring secondary schools should be available to advise and assist with science classes in the primary schools.
- In each district there should be small teams of technicians based in secondary schools and linked to local colleges and universities, who would be available to provide technical support to the primary schools.
- CPD should be used to increase the number of primary teachers with specialist training to teach science. For example, the two-year ‘twilight’ (evening) course leading to a diploma qualification, currently offered by Strathclyde University’s Education Faculty, represents an excellent initiative.
- SEED should provide resources to sustain the *Improving Science Education 5 - 14 Programme* in the longer term.

improving science infrastructure in schools

35 There is an urgent need for investment in school science laboratories, especially in the quality of the accommodation and the equipment (including the provision of computers). It is also vital to provide more technical support so that better, more challenging practical work can be delivered to the pupils. Science subjects must be identified by the pupils as high priority subjects, that are taught in modern well-equipped environments, by enthusiastic well-supported teachers. The recent allocation of £8million and an additional £10million by SEED for science equipment and teacher support is very much welcomed by the SSAC, but it considers that further earmarked direct investments in science infrastructure are required for a more engaging and effective approach to teaching experimental aspects of modern science. Increased technical support in schools will encourage teachers to introduce a wider range of practical activities. This will give the pupils a more stimulating learning experience.

- A rolling investment programme is required to ensure that all schools have modern well-equipped laboratories.
- Technical support in schools must be strengthened so that the pupils can have the experience and stimulation of “hands-on” practical work.
- All secondary schools should have at least one dedicated science technician. Such staff members should be seen as an integral part of the science provision, having access to appropriate CPD and career enhancement opportunities.

the teaching of technology and technical skills

36 There is an approaching crisis in the supply of trained individuals with practical skills in such crucial areas as electrical installation, mechanical fabrication and electronic assembly, plumbing, carpentry, electronic work, plumbing, carpentry and metal work. A modern economy needs a large cohort of trained technologists, technicians and trades personnel with the relevant practical, craft and laboratory skills. Pupils need to be encouraged to recognise that there are excellent career opportunities in these areas.

- **Enhanced support should be given to FE colleges to deliver attractive technology courses, coupled with incentives for students to take the courses.**
- **Schools and colleges should be encouraged to provide the appropriate training packages for students to allow them to progress to technically skilled jobs.**

co-ordinating and connecting science education activities across scotland

37 Many members of the teaching profession feel overburdened by an overcrowded, over-assessed curriculum. At the same time they are bombarded by leaflets and other material from a wide range of groups offering training or “extra-curricular” activities for their pupils. Sifting this information can be time consuming and confusing. **A Scottish Science Education Network** has recently been initiated (**the Institute for Science Education in Scotland – ISES**) and is designed to co-ordinate activity in science support for schools and teachers. It is intended to:

- stimulate the creation of regional hubs that will link with regional schools and teachers;
 - indicate to teachers where the curriculum-relevant resources that they need can be found;
 - indicate to the provider community what the needs of teachers in the region are; and
 - provide a forum for development of the curriculum and for disseminating best practice.
- 38** It is important that support is forthcoming for this network. It will have a primary role in facilitating links between schools, colleges, universities, industry, the SET Points, the Science Centres and all the other organisations involved in supporting science education. The Science Centres themselves also have a particularly important role in stimulating interest and awareness of science and in establishing a scientific culture in Scotland.

- 39** In science it is particularly important to keep material up to date and to be able to introduce new, topical material at relatively short notice. The group recommends that, as a matter of urgency, the universities, colleges, local authorities and SEED should work together to deliver effective CPD for science teachers and to provide topical material to inform and support teaching. The one-week residential Summer Schools currently being offered by Edinburgh and Strathclyde Universities are fulfilling a useful role but there is a need for more 'twilight' (evening) and specific short courses for both secondary and primary teachers to help them introduce new and topical material into their teaching. These CPD activities need to be linked to the activities of the SET Points, the Science Centres, Careers Scotland, and the learned and professional societies in supporting science education. The Institute for Science Education in Scotland (ISES) will be able to play a major role in facilitating and co-ordinating CPD activities.
- **SHEFC and SEED should together provide financial support to formally establish a Scottish Science Education Network (ISES), which fulfils identified educational roles across Scotland.**
 - **SEED should ensure that earmarked funds are available to schools to fund CPD programmes for science teachers. A significant part of this CPD should be in science.**
 - **The Scottish Executive should find a means to provide financial support to ensure the sustainability of the Scottish Science Centres as a network which fulfils a cultural and educational role. This would be similar to the philosophy behind its support of museums and art galleries.**
 - **CPD should be introduced for school careers advisers to improve their awareness of the advantages of studying science at school and beyond in terms of the variety of career opportunities that are on offer to science graduates.**

recruiting and supporting the next generation of high-quality science teachers

- 40** More high-quality science teachers are needed. Steps must be taken to improve the recruitment of science teachers by making teaching a more attractive career for science graduates and a more attractive career for individuals who may be looking for a career change from business or industry into teaching. The present regulations concerning the qualifications required to teach single science subjects, and which prevent secondary teachers teaching in primary schools, need to be reviewed and replaced by more flexible regulations.
- **A reward scheme, for example writing off student debt and/or an enhanced salary package, should be introduced to attract able science graduates into teaching.**
 - **Funding should be made available for individuals seeking a career change from business or industry into teaching, to pursue postgraduate teaching qualifications.**

- The present regulations that prevent science teachers in secondary schools teaching in primary schools and teaching outside their speciality subjects need to be reviewed and constructively relaxed.
- Some younger science teachers should be recruited now, ahead of the high predicted number of retirements, to ensure continuity in science teaching and to avoid staffing difficulties in the future.

research in science education

- Scotland must have links through the Institute for Science Education in Scotland (ISES) to the new National Science Learning Centre in England.
- The Research Policy and Strategy Directorate at SHEFC should work with SEED to make resources available for research in science education.

the way forward

- 41** It is clear that well-focused and prioritised initiatives need to be pursued if science education is to respond adequately to the challenges facing it and 'make the difference' crucial for delivering future prosperity and improved quality of life for Scotland. It is the responsibility of the Scottish Executive to identify how best these recommendations can be resourced, and to identify the policy development bottlenecks that will need to be faced and overcome. A key question will undoubtedly be how to redirect existing resources to best effect. **The SSAC would greatly welcome direct dialogue and the opportunity to give advice on priorities.**
- 42** The SSAC would also welcome the opportunity to be involved, with SEED, the teaching profession, school technicians, local authorities, the HEIs and representatives from industry and commerce, in a wide ranging, long term, review of school science curricula.



working group membership

Professor John Coggins (Chair) – University of Glasgow

Professor Graham Durant – University of Glasgow

Mrs Sarah Fletcher – High School of Dundee

Dr John Whitelock – Fife College of Further and Higher Education

Professor Geoffrey Boulton – University of Edinburgh

Professor Wilson Sibbett – University of St Andrews

corresponding members

Professor Muffy Calder – University of Glasgow

Professor Peter Grant – University of Edinburgh

The Working Group gratefully acknowledges the very helpful inputs to their deliberations made by Dr Les Short, Balwearie High School, Kirkcaldy and the other members of the SSAC.



sources of evidence

Detailed discussions were held with:

- **The ISES Board**
- **Dr Jack Jackson: HM Inspectorate of Education**
- **Mr Bob Kibble: Moray House School of Education, University of Edinburgh**
- **Mr Bill Fleming: Improving Science Education 5- 14 Project**
- **Dr John Richardson: SSERC**
- **Dr Susan Rodrigues: ISES**
- **Professor Alan Roach: University of Paisley**

Members of the Working Group participated in the following major science education events:

- **Science and the Parliament 2002 – which focused on science education in Scotland, November 2002;**
- **A Celebration of Science Year in Scotland, December 2002; and**
- **2020 Science: Education: Science Education in a Changing World, March 2003**

The SSAC carried out a consultation in relation to its forthcoming paper, ***Investing in Scientific Talent***, in June/July 2003. Many responses contained additional and helpful comments on the urgent need to improve school science education, which were pertinent to the work of the Science Education working group. Responses can be viewed on the SSAC web site: www.scottishscience.org.uk

A more comprehensive list of organisations consulted in relation to all SSAC activities, including science education, can be found on the SSAC web site.

membership of the scottish science advisory committee

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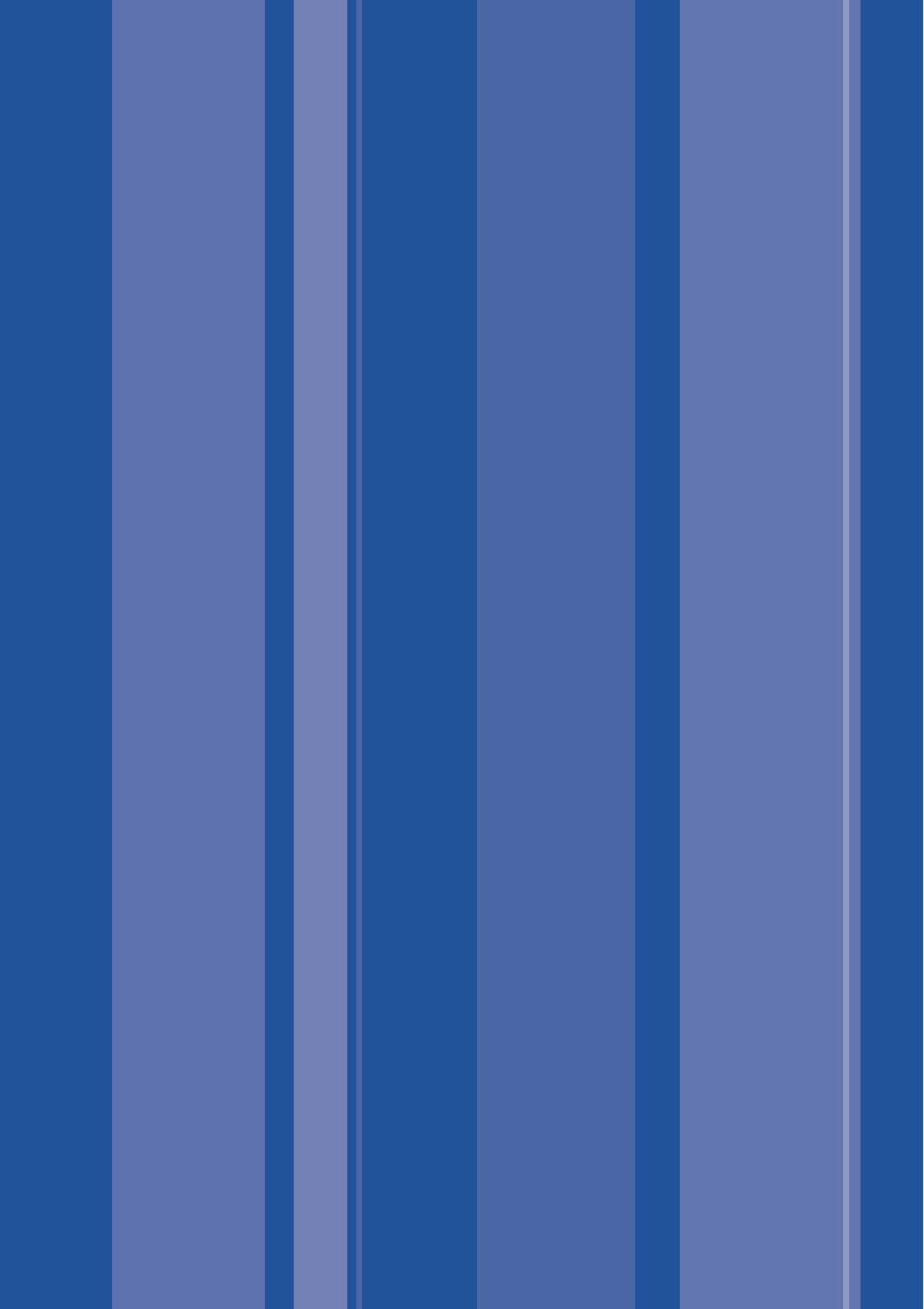
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