



Education & Cultural Services

Policy: Science Education

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Background

The Scottish Executive presented its first integrated Science Strategy for Scotland in 2001. This set a framework which informed detailed development of policy for the support and use of science in all its forms. The importance of school science education was highlighted in the Science Strategy as follows:

“What happens in our schools lies at the heart of making Scotland a scientifically confident society.....School science education has two important objectives: to lay the foundations for the development of Scotland’s future scientists; and to give everyone the skills and confidence to act as informed and questioning citizens in relation to scientific issues.”

Science in schools has received strong support from the Scottish Executive. Local authorities have received additional monies over a three year ministerial commitment 2003-06 to fund science education. This has been directed towards helping schools support the objectives of the science strategy, namely:

- Enable authorities to support the teaching of science in primary schools including CPD;
- Support Initiatives to provide teachers of science with high quality professional updating;
- Secure modern accommodation and resources;
- Practical support to science education to promote science, particularly as a career.

West Lothian Council is committed to providing highest quality learning and teaching in Science education and therefore endorses the recommendations included within important national documents, including:

- *Improving Science Education 5-14 (SEED 1999)*
- *Standards and Quality in the Sciences 1995-2000 (SEED 2000)*
- *Improving Achievement in Science in Primary and Secondary Schools (HMIE 2005)*

HMIE reports have identified strengths and areas for improvement in aspects of science education in Scottish schools. This policy has been informed by both these reports and also good practice across West Lothian schools. This policy has arisen from the significant commitment to improving Science Education in response to the Science Strategy.

In addition, science education should be receptive to the aims and aspirations set out in *A Curriculum for Excellence (SEED 2004)*, and Enterprise Education. This policy is therefore relevant to the principles set out in *Determined to Succeed (SEED 2004)* and *Education for Excellence (SEED 2004)*. Furthermore, science in schools can and should address the National Priorities for Education.

Rationale: Why teach science?

The HMIE report *Improving Achievement in Science in Primary and Secondary Schools* (March 2005) states:

“There is no doubt that science education faces a challenging agenda It needs to fulfil two quite different purposes simultaneously, both to the highest possible standard. On the one hand, it needs to provide inspiration and a sound preparation for the longer term learning and development of young people who will go on to embark on higher study and careers in science-related areas. On the other hand, science education in schools also needs to ensure that all young people are equipped with the knowledge, understanding, skills and attitudes that will enable them to engage positively with scientific issues and debates as they occur in their daily lives. Furthermore, provision has to do all of this in a context in which scientific knowledge is expanding exponentially and new disciplines of study are appearing at an ever-increasing pace.”

In addition to demonstrating scientific knowledge, understanding, skills and attitudes, effective science education gives young people opportunities to be able to interpret and evaluate evidence, take account of ethical, social and economic issues, make informed decisions, communicate effectively about and cope with future scientific developments. Its relevance to modern society in relation to aspects of the quality of life, economic development and the sustainability of the global environment is vital in making Scotland a scientifically literate and confident society.

Aims of the policy

- To provide a common framework for science education policy and practice within West Lothian schools.
- To seek to ensure continuous improvement in the quality of learning and teaching and of pupils' attainment in science throughout our schools.
- To support staff in providing quality science experiences for all pupils within West Lothian Council which:

- broaden pupils' understanding of themselves, the society in which they live and the world as a whole;
- develop a scientific approach to problem solving, encouraging critical thinking about phenomena, events and issues;
- develop positive attitudes to science and its contribution to and impact on society.
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- encourage consideration of science as a potential career opportunity.
- To raise staff awareness of the importance of CPD given
 - the rate of growth in scientific and technological developments
 - the need to address the science for citizenship agenda through class teaching

The science curriculum

Children should experience science from the earliest opportunity and should be encouraged to explore, question and appreciate the world around them as skills of life long learning.

The cycle of continuous updating and reform of the curriculum across all areas of learning is underway, starting with the science curriculum 3-18. All of the existing science curriculum will be assessed against the principles and purposes of *A Curriculum for Excellence*, with implementation of the revised scheme planned for session 2006-07. However recent national and local advice suggests that the science curriculum should:

- identify "big questions" in science as a way of organising and clarifying the purpose of activities;
- focus on teaching for understanding;
- integrate science for citizenship;
- identify a range of skills and how they are taught in context.

Effective courses at all stages should:

- take appropriate account of pupils' progress and prior experience and attainment;
- be well planned to make good use of time, and ensure steady progress and time for learning to be embedded
- have clear learning intentions and assessment criteria which are shared with pupils and used to guide teaching;
- include relevant and challenging content, including **practical work**, supported by the teaching of thinking skills, that captures pupils' interest and develops the full range of investigative skills;
- emphasise key areas of contemporary science and their applications, including the benefits and risks to global society; and
- take account of vocational relevance.

The structure and balance of the 5-14 curriculum recommends that 15% of the pupil week be dedicated to the teaching of Environmental Studies, of which science is a component. Although schools may structure timetables to deliver science as a discrete subject, it also lends itself to being integrated within a range of curricular areas in the pre-school and primary stages. However, in these circumstances, schools should ensure that the **scientific learning outcomes** are clear. Curricular delivery in secondary schools should take account of the need to avoid duplication and overcrowding and should seek links between the sciences, other curricular areas and

cross curricular whole-school themes such as citizenship, health promotion and enterprise.

Clusters should agree a science programme which ensures continuity and progression from pre-school to early secondary. Opportunities for collaborative planning for science should feature within cluster liaison arrangements to support effective transition from nursery to P1 and P7-S1. To facilitate this, in addition to cluster management meetings, nursery/primary and primary/secondary liaison should be formally established during dedicated time in the cluster calendar. Cluster representatives should meet to plan, monitor and evaluate provision. Such cooperation should make best use of the talents of staff in all sectors and encourage each to learn from the other in line with 'Succeeding Together'.

All schools should identify a science coordinator to link with others both within and outwith the school. The science co-ordinator should be a point of contact for authority personnel, school management, staff and cluster. The core role of a science co-ordinator is to:

- raise the profile of science with staff, pupils, parents and local community;
- influence the development of science in the school with management, staff and cluster;
- liaise with management and teachers to ensure appropriate time allocation to science;
- support colleagues;
- keep up to date on matters relating to the science curriculum;
- networking with science co-ordinators.

Science beyond the classroom

The world beyond the classroom has many rich contexts for learning and teaching. The development of informed attitudes to environmental issues and experience of science in life and work can be enhanced when pupils are exposed to the world outside school. Schools should work with the science community in further and higher education and industry to harness willingness to provide practical support to school science education, and to promote young people's understanding of, and enthusiasm for, science as a career or as an interest. This could include developing the school grounds, inviting parents/guests to talk about aspects of science and the environment, offering work experiences, promoting industry links, arranging field trips, participating in national and local science challenges and competitions, Careers Scotland events and celebrating science week.

Learning and teaching, assessment and meeting pupils' needs

(Related advice is contained within the council's Learning and Teaching and Equality policies.)

To deliver a stimulating, relevant and dynamic curriculum practice must reflect the highest standards of learning and teaching and make best use of resources. From the 1907 *Scotch Code* to the *Science Strategy for Scotland*, educational reports have consistently encouraged teachers to adopt an **experiential approach** to the teaching of science. In all curricular areas, children are expected to develop concepts actively rather than be passive consumers of instructors' presentations.

Active science education should involve creativity, entrepreneurial skills, personal construction of meaning and understanding and problem solving. There should be a clear balance between the acquisition of knowledge and understanding and the development of skills. Every opportunity should be taken to link learning to the

application of science in daily lives. Learning activities are most effective when they are stimulating and engage pupils actively in their own learning. Science offers a vehicle for this through pupils carrying out practical investigations and in developing thinking skills associated with problem solving, reasoning, drawing conclusions, analysing and evaluating evidence and hypothesising.

Pedagogy in science should reflect current developments in learning and teaching methodology, including thinking skills and assessment for learning. While curricular content may change, the fundamental ideas that teachers try to convey to learners remain the same. Science should provide the means by which learners can interact with the world around them and develop ideas about the phenomena they experience. The focus of science education should be for teachers to find out what the learners think. A mainstay of pupil learning is discussion, between pupil and teacher, and between pupil and other pupils in their group / class. Opportunities for pupils to express their understanding should be designed into any piece of teaching. Teaching should then provide learning experiences that help pupils to consider and, if necessary, modify their ideas and develop further scientific understanding.

Effective learning and teaching in science should be inclusive and take account of **all** pupils' abilities and preferred learning styles and practice should:

- build upon children's prior learning and existing ideas about the world around them;
- have a clear purpose and be planned with explicit learning intentions;
- have lessons with a clear structure: beginning, middle and plenary;
- confront pupil misconceptions and develop new concepts;
- address key concepts as 'big ideas' or 'key questions';
- be experiential, active and include investigative approaches;
- provide opportunities for independent and self directed learning;
- provide opportunities for higher order thinking through carefully planned questioning techniques;
- include direct teaching, where the teacher interacts with pupils as they work, and questions them to check their understanding of key ideas;
- occur within a collaborative learning environment;
- encourage pupils to ask thoughtful and perceptive questions which challenge their peers and teachers;
- include opportunities to discuss science issues, including those which have social, moral and ethical implications;
- include feedback on pupil learning which identifies key strengths and areas for improvement;
- support peer and self-assessment and learning about how to learn;
- make appropriate use of modern resources and technologies in a variety of environments;
- Include purposeful, stimulating and innovative homework activities.

Assessment

Assessment, formative and summative, should be an integral part of the science curriculum. All schools should ensure rigorous and systematic approaches are in place for assessing pupils' learning in science. Teachers should be clear about pupils' performance in relation to learning intentions. Assessment information should be used to identify realistic and challenging targets for all pupils. Formative assessment should be embedded in learning and teaching.

For effective assessment in science schools should ensure:

- recognition of the profound influence assessment has on the motivation and self-esteem of pupils, both of which are crucial influences on learning;
- at the planning stage, key knowledge, understanding and skills are identified for all pupils and how this learning will be assessed;
- in S1, teachers use information provided on pupils' attainment in science in primary school to help inform their expectations of pupils' achievement;
- challenging, realistic targets are set for all pupils;
- pupils are told what criteria will be used in assessing their work;
- teachers use a variety of approaches to assess pupils' progress, including questioning, observing skills, practical investigations and challenges, examining written and other examples of pupils' work, and end-of-topic tests;
- provision of effective feedback to pupils;
- active involvement of pupils in their own learning by engaging pupils in discussion; and ensuring that pupils record and refer to these discussions in day to day work;
- pupils are able to assess themselves and understand how to improve;
- teachers regularly discuss pupils' progress and liaise with others to help support those who are under-performing;
- for consistent standards, teachers moderate samples of colleagues' assessments of pupils to match performance to national levels of attainment;
- the success of different groups in achieving particular learning targets is recorded systematically, along with any individual pupil aptitudes or development needs;
- attainment in each class/group is analysed to identify patterns or trends in attainment and to inform next steps;
- teaching is adjusted to take account of the results of assessment.

Meeting pupils' needs/Inclusion and Equality

All pupils should be encouraged to see themselves as scientists. There should be recognition of the contribution of scientists regardless of gender, and from a diversity of cultures. Learning in science should have pace and challenge for **all** pupils, irrespective of race, gender, disability or other barriers to learning, including pupils from a range of cultural backgrounds, ethnic groups and from diverse lingual backgrounds. Scientific experiences should be set within a culture of high expectations for all pupils to achieve. Good use should be made of specialist and support staff. Secondary schools should offer a suitably wide range of courses to allow pupils to make progress and meet their needs and interests. More able pupils should have opportunities for extending their learning. Staff should be aware that scientific language can in itself present barriers in learning so pupils should be encouraged to explore the meaning of both technical and non technical words.

Curriculum planning should take into account the need to ensure a safe and secure classroom environment where children can learn with confidence. To meet the needs of all pupils, staff should consider specific action to challenge stereotypical views and respond to pupils' diverse needs by:

- ensuring that the curriculum reflects and extends the experiences of all pupils;
- providing opportunity through teaching approaches and access to resources;
- taking into account specific religious or cultural beliefs;
- modifying tasks by differentiating learning intentions, activities and resources;
- providing exploratory tasks for challenge and descriptive tasks for those requiring more structure;
- changing the extent to which the teacher or assistant supports the task;

- providing additional challenge by making tasks more open ended or by presenting them in a less familiar context

Creativity through science education

Creativity lies at the heart of scientific discovery and invention.

To develop creativity, tasks should be open ended and foster the purpose of science in society and how scientific styles of thinking can help in other areas of life. School science education should provide rich and varied contexts where pupils can be challenged to think creatively and critically to:

- solve problems;
- become innovative and enterprising;
- equip them for their future lives as workers and citizens;
- respond positively to opportunities, challenges and responsibilities.

To promote creativity in science, teachers should ensure that science programmes include:

- options and choices to allow pupils to come up with ideas beyond expectations;
- discovery by generating a range of possibilities to answer the question 'Why does this happen?'
- opportunities to foster imagination and bring together existing ideas, information or evidence in original ways to generate new entities or ideas.

Resources

Science teaching requires a range of resources to promote active, investigative learning. Resources should be motivational, stimulating and up to date. Equipment is an important feature of science and has a role to play in developing how pupils work and think scientifically. The development of pupils' understanding of the use of equipment should be planned across stages and sectors. Resources are the responsibility of the teacher. Advice can be sought from the science co-ordinator. Teachers should encourage pupils to take responsibility for care, maintenance and safe use of equipment.

Resources should be:

- wide ranging;
- safe and well maintained;
- fit for task and used appropriately
- user friendly;
- appropriately stored;
- clearly labelled;
- counted out and in.

The roles of teaching and support staff(technicians/classroom assistants as appropriate) should be stated in school or department policies

Role of ICT

ICT provides access to a wealth of science resources and is a powerful tool for learning. Learning activities and investigative work should be supported and enhanced through appropriate and relevant use of ICT. Science programmes should include interactive use

of ICT and ICT should be deployed for staff and pupils to access, process and present scientific information and data.

Health and Safety

The Health and Safety at work act and its various regulations apply to schools as much as to any other work place. Risk assessments should be carried out for all activities¹ and a health and safety log or equivalent should be maintained. A characteristic which distinguishes pre-school and primary establishments from secondary schools is that science is normally taught by a non-specialist in non-specialist accommodation.

However, the foundations of safety in science are common to all sectors:

- clean and tidy habits;
- adoption of sound “ laboratory” practice;
- good discipline;
- the strict prohibition of unauthorised practical work;
- staff knowledge of the hazards involved and risk assessment;
- safe use, storage and disposal of equipment, chemicals and waste;

Safety should be uppermost in every aspect of teaching science, both in indoor and outdoor activities. It should be approached in a positive manner, dealt with in context and considered at the planning and carrying out stages of scientific activities.

All schools should have an agreed set of clear and concise science/laboratory rules which are taught to pupils and are displayed. Pupils should be trained in safe practices and should be taught basic principles of risk management. They should learn to:

- recognise and identify specific hazards;
- assess risks;
- take steps to eliminate or control the risks to themselves and others.

In the early years pupils should be able to answer questions about simple rules for keeping themselves and others safe when handling science equipment. In the middle primary stages, pupils should be able to use a given set of safety rules which can be applied to investigation plans. In the upper primary and secondary stages pupils should be able to suggest their own procedures for keeping themselves and others safe.

Particular advice relating to council policy is available on the Council and Education Services websites. Schools must make reference to this when producing their own guidelines. In support of further specialist advice, the council is a member of SSERC (Scottish School Equipment Research Centre). **Staff should read regular newsletters and access information from SSERC via the SSERC website.** Training and advice covering all aspects of practical work in science can be accessed from:

SSERC
2 Pitreavie Court
South Pitreavie Business Park
Dunfermline, Fife
KY11 8UB
Tel: 01383 626070
E mail:sts@sserc.org.uk

There is a very useful Website:
www.sserc.org.uk

Advice is also available from the Association of Science Education (ASE) at www.ase.org.uk and from the Health and Safety Executive website www.hse.gov.uk

CPD and sharing good practice

Across the sectors and within the sciences it is proving challenging to keep the content of courses up to date and relevant to the needs of society. School managers and individual staff should address professional development needs by accessing the range of opportunities offered at both local and national level:

- West Lothian Council's Education Officers, DOs and CSTs
- the range of science specific professional bodies
- further and Higher Education Institutions
- industry
- accessing a range of websites, in particular LTScotland's WWW.LTScotland.org.uk and SSERC's Improving Science Education website www.ise5-14.org.uk

Managers at all levels in schools have a key role in monitoring and evaluating pupils' classroom experiences. Good practice should be identified and promoted both within and across other schools. Advice and support should be targetted.

Adopting the policy

All of the recommendations made within this policy are built upon pertinent National guidelines and advice. They provide opportunities at local level for audit and evaluation against best practice, and should also be read in conjunction with other West Lothian Council policies. Regularly thereafter, along with staff, the Headteacher, or the teacher with responsibility for science, should audit programmes to ensure that practice within the school continues to reflect West Lothian Education and Cultural Services policy for science education.

Customers with Special Requirements

Information is available in Braille, tape, large print and community languages.
Please contact the Interpretation and Translation Service on 0131 242 8181.

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