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School Science Laboratories: Today's Trends and Guidelines

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PEB Exchange Programme on Educational Building

SCHOOL SCIENCE LABORATORIES: TODAY'S TRENDS AND GUIDELINES

This article reports on practice in a selection of OECD Member countries. It is not a comprehensive survey. PEB is compiling a dossier on this subject which we plan to make available on the PEB Web site. We invite readers to send other recent references to the Secretariat.

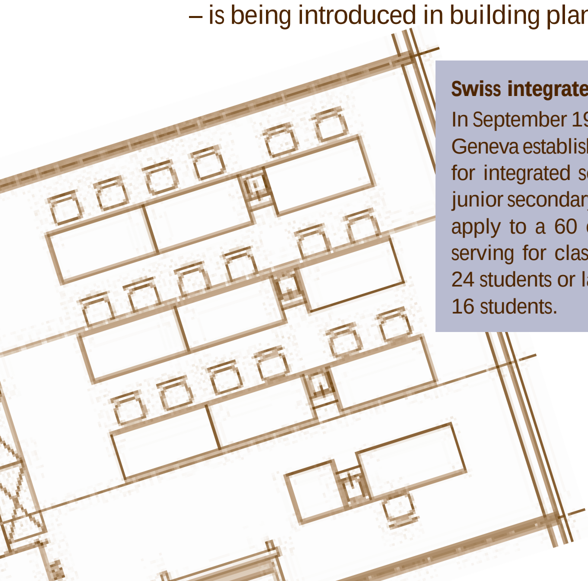
Science laboratories in schools are expensive to equip and maintain. Specific pedagogical needs, new technology and safety requirements contribute to the costs. In an effort to get the most efficient use of facilities, some countries are rethinking school labs with a move toward more flexible approaches.

Switzerland: flexibility and integration

In junior secondary schools in the Canton of Geneva, chemistry, physics and biology are taught for the most part in "versatile" classrooms; each subject has one room which serves for both whole-class teaching and individual practical work. All equipment is mobile other than a series of stations with outlets for water, gas and electricity. While at the level of upper secondary education each science subject traditionally has its own laboratory and separate classroom, versatile classrooms are replacing these in new and renovated buildings (where theatre seating for example is being removed).

The Public Education Department of the Canton of Geneva cautions against choosing designs with fixed installations that are so rigid and sophisticated that they cannot be adapted to changes in use. It promotes "simple solutions allowing for change, not only because of costs and installation time, but mostly because of the need to be able to easily adapt the facilities to different uses in the future."

The idea of integrated science laboratories – one space shared for biology, chemistry and physics experiments – is being introduced in building plans for the future.



Swiss integrated laboratory
In September 1998 the Canton of Geneva established specifications for integrated science rooms for junior secondary education. They apply to a 60 or 80 m^2 surface serving for class work for 16 or 24 students or lab work for 12 or 16 students.

Computer-assisted experiments in France
Within ten years at a school with two laboratories, each equipped with six PCs, 4 000 students were able to do computer-assisted experiments. New installations are designed to allow students to work in groups.

France: incorporating new technology

The French Ministry of Education sees a growing need to equip upper secondary schools for science instruction using modern technology, such as multimedia computers connected to local networks and Internet, video recorders and players, overhead projectors and televisions that can be connected to computer and video equipment in addition to picking up stations.

Beginning in 1987, facilities were installed in upper secondary schools for computer-assisted experiments. Since 1997 France has been installing multimedia stations and computer peripherals in biology labs. PCs are being networked so that students can share materials and work together. Portable equipment for computer-assisted experiments will be introduced in the years to come. The laboratories remain equipped for traditional experimental work.

In junior secondary education, chemistry and physics share facilities: laboratories, combination collection/ preparation rooms and teacher research rooms. At the upper secondary level this is not always the case; physics and chemistry do however share laboratories for computer-assisted experiments.

The Government recommends a classical layout for science labs, one that is wide and not too deep in order for students to see teacher presentations and experiments at the front of the room. The Ministry warns that no other discipline should be taught in physics and chemistry labs for "safety reasons and in the presence of fragile and costly materials .... This constraint allows major savings in the institution's maintenance by avoiding damage."

Ireland: safety first

The concern for safety is the starting point for guidance from the Irish Department of Education to schools and teachers. Below are examples of Ireland's recommendations concerning various aspects of school laboratories, published in the government manual *Safety in School Sciences*:

Design and accommodation:

- Structural: There should be ample light (500 to 1000 Lux) and good ventilation (7 to 15 air changes per hour).
- Organisational: Areas should be available in the laboratory for on-going experiments, for wet and dirty work and for permanent apparatus and specimens.

General services:

- It should be possible to isolate the supply of gas and electricity by emergency stop buttons at the teacher's position and at the exit or outside the classroom.
- Gas taps should be such that they cannot be turned on accidentally.
- There should be no steps in the laboratory or between the laboratory and the preparation room.

Electrical services and equipment:

- Equipment must be suitably identified and marked, including the maker's name and its electrical ratings.
- Where possible such equipment should have a pilot light to indicate when it is switched on.
- Portable electrically operated equipment should be inspected at regular intervals and a record kept of inspections made.

Hygiene and first-aid:

- One or more fully trained first-aid persons should always be available on the school premises during normal class times.
- Laboratories should be equipped with an adequate supply of waste boxes, preferably of two distinctive kinds, one for dry and broken waste and one for wet waste such as filter papers and biological materials.

South Australia: planning for sustainability

Ann Gorey, of the Administration and Information Services which advises the South Australia Department of Education, Training and Employment on technical details, legislation and asset management strategies, stresses that planning for school science laboratories should address long-term educational and structural implications. This requires a careful look at three key areas of sustainability of the design:

- Educational sustainability: meeting the needs of the curriculum and matching ways in which students learn (e.g. team work, collaborative learning or self-directed research);
- Environmental sustainability: including design features such as natural light and ventilation; planning for the responsible disposal of chemical and other waste;
- Physical sustainability: ensuring the building's "fitness for purpose"; complying with legislative requirements; providing flexibility.

Facilities that respond to these criteria run from low-cost to high-cost options. At the Unley High School in Adelaide which has older style classrooms, the senior science teacher has been able to create a dynamic learning environment by using moveable tables and a wide range of low technology. St Peter's Boys School is an extensive new centre designed to demonstrate the principles of natural lighting and flexibility; features of its buildings include recycled water, solar energy and linking of indoor and outdoor areas.

Maryland: a comprehensive approach

Science facilities in upper secondary schools in the US State of Maryland are being renovated to provide students with state-of-the-art facilities. In the six years since the governor initiated the LOOK OF THE FUTURE programme, 345 labs were approved in 77 schools with a state investment of US$27 941 000.

Planning guidelines prepared by the state are intended to respond "to evolutionary changes in education, including emphases on the processes of science, the application of scientific thinking to broad content areas, the introduction of electronic communications into the science laboratory, and the inclusion of all students, including those with disabilities, in the full range of science activities," as described by State Superintendent of Schools, Nancy Grasmick. Maryland is sensitive to environmental implications and encourages "ecologically-sound design practices".

Maryland's science facilities other than labs and lecture areas include student project rooms, for advanced research and long-term projects, greenhouses and science studios. The latter is a new programme space, for projects involving more than one discipline, which "supports a hybrid of pure and applied science and is particularly appropriate for team teaching science and technology education."

REFERENCES

***Guide d'équipement: physique et chimie en collège* (May 1998),**

***Guide d'équipement: physique et chimie en lycée d'enseignement général* (June 1998),**

***Guide d'équipement: physique et chimie dans les sections d'enseignement professionel* (June 1998); Ministère de l'Éducation nationale, de la Recherche et de la Technologie, France.**

These equipment guidelines for different levels of secondary education cover all issues related to installing facilities in new or renovated buildings: teaching objectives, technology, costs, hygiene and safety. They provide layouts for classrooms, traditional and computer laboratories, collection/preparation rooms and teacher resource rooms, and they list the most suitable equipment and quantities of materials needed.

***Safety in the School Laboratory: Disposal of Chemicals* (1996), Irish Department of Education, Dublin.**

This a collection of "user friendly" safety data sheets on 161 chemicals – all those on the syllabus and other common chemicals – compiled for quick reference by teachers.

***Safety in School Science* (1996), Irish Department of Education, Dublin.**

This 114-page document written for teachers and school management is a code of practice on laboratory design and services, organisation and management, hazards and safety precautions, emergency procedures and useful practical techniques. The principles and guidelines given aim "to allow the efficient conduct of practical work ... with a view to preventing accidents."

"School Science Laboratories: Planning for Sustainability" (1998), Ann Gorey, South Australia Department for Administrative and Information Services, Adelaide.

Paper available on the PEB Internet site under What's New at http://www.oecd.org/els/edu/peb/els_peb.htm.

The paper describes what is meant by educationally, environmentally and physically sustainable laboratories. It lists fifteen questions to ask when planning to build or refurbish a facility, such as who is responsible for identifying new trends, what is the focus of the space and whether a staff familiarisation programme has been planned. Three Australian schools are described whose facilities range from low-cost to high-cost options.

***Science Facilities Design Guidelines* (1994), Maryland State Department of Education, United States.**

This publication provides details of all aspects of science facilities – from planning and the role of each party involved, to construction, to Post-Occupancy Evaluation – for all new schools, renovations and additions, from kindergarten through upper secondary education. Planning recommendations include evaluating outside assets (e.g. partnerships with local colleges, industry and museums) that can affect requirements within the building, and designing the school site for use for science and environmental education.

FURTHER READING

***Changing the Subject – Innovations in Science, Mathematics and Technology Education* (1996), OECD/Routledge.**

Drawing on 23 case studies from OECD countries, the authors concentrate on the origins and purposes of innovation within and across the science, mathematics and technology curricula and explore the involvement of teachers and students. They reflect on strategies adopted to cope with and bring about change.

***Fume Cupboards in Schools* (1998), Architects & Building Branch of the Department for Education and Employment, United Kingdom.**

This bulletin "covers the level of provision that is desirable to meet curriculum needs and makes recommendations for good practice in the design, specification and installation of fume cupboards."

***Middle Schooling Matters in Science: Strategies for Learning and Teaching* (1998), South Australia Department of Education, Training and Employment, Adelaide.**

This manual is a professional development package designed by teachers for teachers, to support effective learning and teaching in science for students aged 12 to 15. It advocates a "hands on" approach to science.

***Planning Guidelines: Secondary School Science* (1998), South Australia Department for Administrative and Information Services.**

This guide provides a broad description of the requirements for facilities and makes specific reference to requirements that are legislated.

***Safety in Science Education* (1996), Department for Education and Employment, United Kingdom.**

This document provides legal advice, relevant health and safety legislation and information on risk assessment for teachers and technicians.

***Utrymmen och Utrustning för Undervisningen i Naturvetenskapliga Ämnen (Space and Equipment for Teaching Natural Sciences)* (1997), Marja Montonen (ed.), Finnish Ministry of Education.**

This publication covers:

- objectives and methods for teaching sciences at the primary and secondary levels;
- designing instructional space; planning for ventilation, electricity and water supply and evacuation;
- equipment; labelling, storage and destruction of chemicals and biological matter;
- first aid training; safety practices for teaching in laboratories.

"Widening the Appeal of Science in Schools" (1998), Edwyn James, *OECD Observer*, No. 214, October/November.

This article is an overview of the knowledge gained from *Changing the Subject* (above) and presents implications of the current learning situation for the teacher.

WEB SITES

Association for Science Education – http://www.ase.org.uk/

The full text of "Inspecting Safety in Science: A Guide for Ofsted Inspectors in Primary Schools", produced by CLEAPSS, is found here along with a guide for secondary schools. Safety-related articles from ASE journals are also available at this site, as well as a list of publications on safety.

***Centre national de la recherche pédagogique* – http://www.cndp.fr/**

Recent articles on multimedia laboratories are available under the section *Publications en ligne*.

***Le groupe "Sciences Physiques Internet" de l'Académie de Grenoble* – http://www.ac-grenoble.fr/phychim/cadrprin.htm**

This site provides a variety of references on safety in the chemistry laboratory.

***Multi-média et Internet : des outils pour l'enseignement* – http://perso.wanadoo.fr/svt1/**

This site of the French National Research Group for ITC in Life and Earth Sciences offers a visit to a biology laboratory and an example of student lab work using information technology and communications.