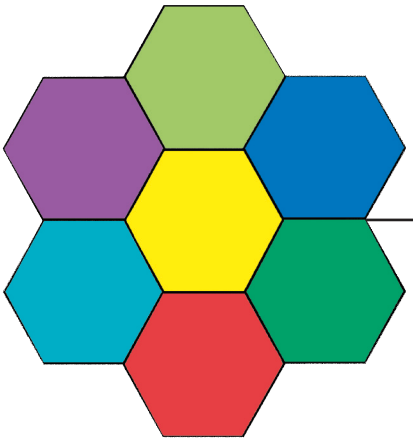

Learning Skills for Post-16 Sciences

Introduction

Nuffield Curriculum Centre

Weizmann Institute of Science

Gatsby Science Enhancement Programme

Learning Skills for Post-16 Sciences

Developed and produced for schools in the UK by the
Nuffield Curriculum Centre and Gatsby Science Enhancement Programme

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Project resource website: http://www.sep.org.uk/lss

Development and implementation of the programme

Learning Skills for Science is based on the Scientific Communication programme created at the Department of Science Teaching, Weizmann Institute of Science, and used in schools in Israel.
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In 2004 the Science Enhancement Programme (SEP) commissioned the writing of activities and developed the materials, training and resources for use in the UK with a focus on the revised Science GCSE. In 2008, the activities were further developed in a partnership between Gatsby Science Enhancement Programme and the Nuffield Curriculum Centre for use with Post-16 Science studies.

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SEP
Science Enhancement Programme

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Learning Skills for Post-16 Sciences

Science education aims to prepare all students for life in a world of rapid scientific and technological change, as well as preparing a smaller number for highly specialised scientific careers. The U.K. GCSE specifications revised for first teaching in 2006, introduced the area of 'How Science Works' into the science curriculum for 14-16 year olds. These aspects of science were introduced into A-level specifications from September 2008.

The new specifications emphasise the applications and implications of science, so students are motivated to relate what they learn in the science classroom to their own lives. Student-centred teaching and learning approaches are also encouraged, and high-order skills are crucial for these more active processes. High-order skills include enquiry and problem-solving skills, thinking skills and learning skills (see Figure 1). Specific development of these skills recognises the need to prepare students for higher education and employment, by supporting their development as independent learners.

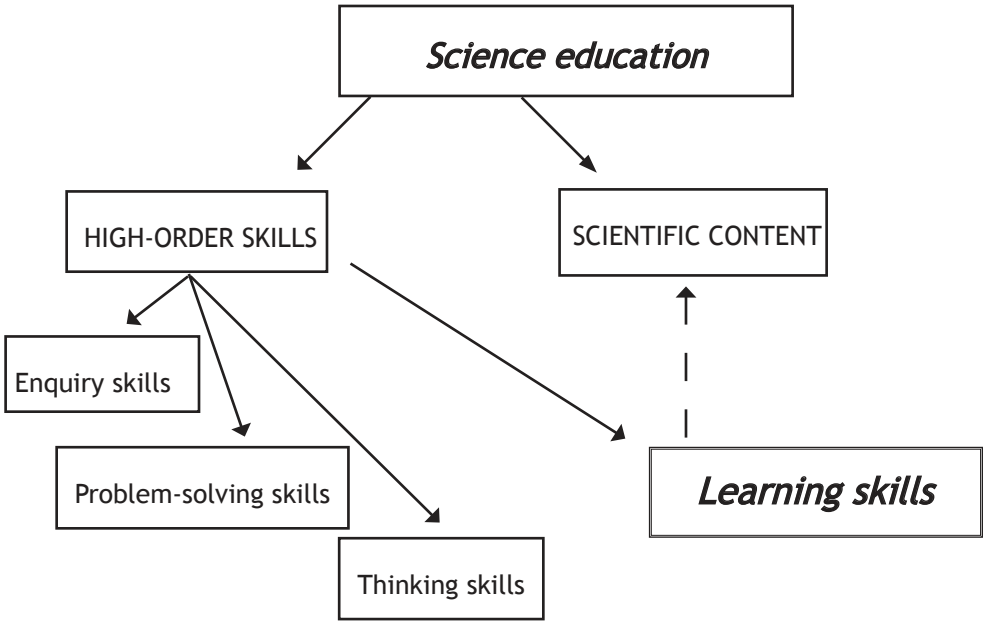

Figure 1 Components of scientific study

Previously, learning skills for science were acquired through trial and error. The Learning Skills for Science (LSS) programme helps teachers to integrate these skills into the teaching of scientific content. It provides activities to facilitate explicit, guided, and well-planned learning opportunities that foster skills development.

Aims of the programme

Learning Skills for Science aims to enhance the quality of science learning and so improve student attainment by providing teachers with:

- strategies to identify and deconstruct learning skills relevant to science education
- activities which develop students' learning skills in the context of science
- resources that can be integrated into a variety of scientific subjects.

Teaching model

The programme focuses on six 'Learning Skills Areas' of information retrieval, listening and observing, scientific reading, data representation, scientific writing and knowledge presentation. Each of these is further divided into sub-skills. For example, scientific writing provides practice in how to prepare a summary, write an article and construct a bibliography (Figure 2).

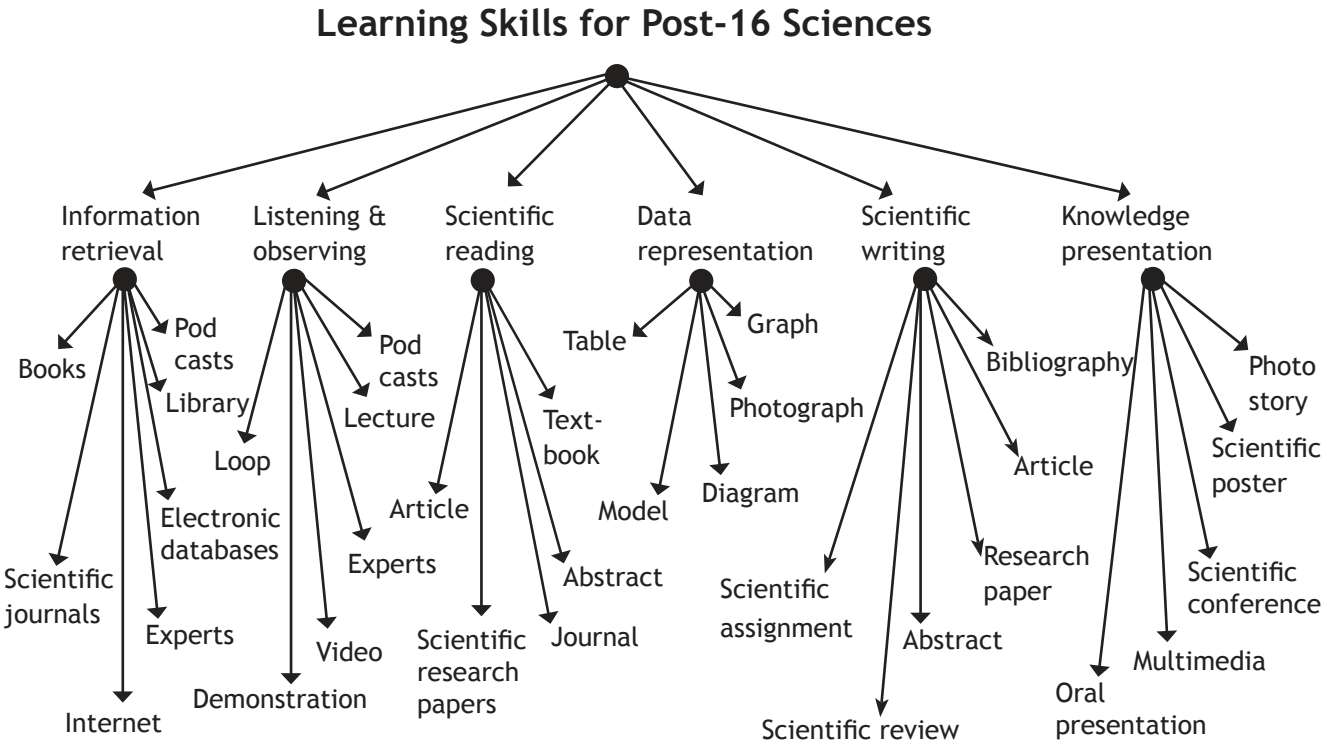

Figure 2 Learning skills and sub-skills

Characteristics of the programme

The Learning Skills for Post-16 Sciences programme contains activities and resources which are specifically mapped to the content of the GCE science specifications, including Biology, Chemistry, Physics, and Applied Science. Ideally, the activities should be fully integrated into schemes of work. Because the science content is covered along with development of a particular skill, the activities should not require substantial additional curriculum time. Time devoted to development of these skills in the early part of an advanced course will be made up for as students become able to access these skills to the advantage of their learning experience.

Input skills The first three Skill Areas represent different ways of accessing information. Information has never been so readily available. However, filtering information to discern what is useful and relevant is a challenging but vital skill.

Output skills The second three areas represent skills involved in synthesising, interpreting, and representing knowledge. To synthesise, interpret and represent knowledge, students must acquire the higher order skills of processing and constructing information.

Transferable skills Activities have resources that link with an area of the current GCE science specifications in England and Wales. It is anticipated that students will be provided with opportunities to practise these skills throughout the course. Explicit teaching of the skills in different contexts will strengthen the students' ability to transfer their skills, and to select and use them appropriately.

Modelling The activities requiring 'output' skills may be challenging for many students. Recommendations are provided for how teachers might model the skill and provide scaffolding to support students' learning. As students develop as independent learners, the scaffolding can be removed.

In the curriculum links, suggestions are made for the stage in the course where activities should be carried out, acknowledging that the degree of challenge varies. The activities can be differentiated according to the amount of scaffolding and the nature of the resources provided.

How does LSS work to raise attainment?

When we learn, information is stored temporarily in our working memory. This can be compared to a processor in a computer. Our working memory can only manage a certain amount of new information at one time. The amount of new information that the working memory has to deal with at one time is called the cognitive load. The working memory has limitations. If material to be learned is too complex, there is too much of it presented at one time, or there are too many overlapping demands (high cognitive loads), then learning will be inhibited.

LSS provides strategies to decrease the extraneous cognitive load, or the strain put on the working memory by how information is presented. Additional load could be due to the nature of the information, quantity of the text, language used and / or complexity of the visual presentations. The explicit teaching of skills in LSS supports students by providing them with strategies to recognise and process information irrespective of how it is presented. These strategies are learned and automated, providing more processing capability to deal with complex science ideas, or the intrinsic cognitive load.

Providing students with opportunities to practice exam questions and with worked examples has a similar effect. As students become more familiar with the structure of the exam questions they are more able to engage successfully with the content.

What is the ideal teaching model?

Familiarise Teachers will need to familiarise themselves with the LSS skills, sub-skills and strategies before embarking on the activities.

Explicit instruction The skills and strategies should be taught explicitly in a well-planned manner. Students should be provided with opportunities to assess their progress, and to identify the next steps in their skill development.

Integration The instruction should integrate LSS with the scientific content. Skills should be taught when relevant within the course of study. Students should be provided with opportunities to discuss their application of the skills (metacognition).

Variety and repetition Skills should be applied repeatedly in a variety of contexts throughout the curriculum. This will strengthen students' capabilities in transferring their skills. An expert learner is able to identify and access the skills needed for a particular task.

Learning Skills for Science resources

Activity folder of photocopiable briefing sheets and instructions for their use in the classroom.

Website providing supporting resources such as scientific articles, texts, weblinks and briefing sheets that can be downloaded for modification and reproduction. Teacher modified resources will also be uploaded to ensure exchange of good practice between teachers using the programme.

Training courses for teachers and trainers are available through the SEP professional development leads, National Network of Science Learning Centres, Secondary National Strategy consultants and QIA Post-16 Science leads.

Using this resource

Everything in this folder is also available electronically on the LSS website (see below). There are also additional resources on the website. You need a password to access this site. See the website home page for details of how to access the resources.

http://www.sep.org.uk/lss

The curriculum links section at the beginning of each Skill Area suggests where activities may be introduced into the post-16 curriculum, and some suitable resources such as articles and weblinks are provided. However, the activities are intended as models which can be adapted by teachers to relate to a wide range of science content. Word documents of the activities are provided on the LSS website to allow them to be adapted easily.

In this folder, some activities and curriculum links are provided for one or two science areas only. These activities can be adapted for the other science areas by sourcing appropriate resources such as articles and weblinks.

The activities in this folder include web addresses. When you access the electronic versions of the activities from the website, you can click on the live links to go straight to the recommended websites. If the web addresses become obsolete, or need to be added to or changed, these will be updated in the activities on the website. For these reasons, it is worth downloading the latest versions on the website for students to use.

Skill Areas

Skill Area 1 Information retrieval

Information retrieval is a wide, often loosely-defined term the meaning of which has changed considerably with the expansion of the World Wide Web ('the Web') and mass storage devices. Students seeking specific scientific information should look for professional and reliable information not only in the realm of the Web, but also in the libraries and archives of professional institutions. Therefore in addition to the Internet as a general information source, this Skill Area considers text books, the British Library, online journals, experts in the field, and surveys.

Irrespective of the exact means of information retrieval being used, searching for *objective and reliable* information about a specific subject is not easy. Strategies for how to evaluate information and their sources are considered in detail.

Skill Area 2 Listening and observing

In science, listening and observing is still one of the most popular ways that students are expected to learn. Studies show that the novice listener who has not acquired listening skills can absorb only 50% of the information transmitted. After 48 hours, they will be able to remember only 25%. Listening is largely an invisible and untaught skill, despite being an essential tool for learning.

Skill Area 2 deals with active listening, guided observing, summarising and making notes, critical thinking, asking focused questions and thinking from different points of view. These skills provide a framework to help maintain concentration and maximise learning through listening and observing. Independent learning skills required for H.E. lectures, talks by visiting speakers / experts, podcasts and film are developed through these activities.

Skill Area 3 Scientific reading

Scientific reading is reading for information. Reading scientific literature poses challenges. When reading research papers and articles there is often an assumed prior knowledge that the reader may struggle with. Text with lots of information and subject-specific language demotivates and slows down the reader. All this leads to poor comprehension and a reluctance to engage with further scientific texts.

Deconstructing the skill and providing scaffolding to support students will help them develop and make use of scientific reading within their studies.

The first part of this Skill Area introduces skimming and scanning. These are selective reading strategies which will support more effective study and learning. Students are used to reading science textbooks, which generally require everything to be read for understanding. But when dealing with research tasks, articles and scientific papers it is not always necessary to read everything.

Reading is an important study skill. The second part of this Skill Area considers reading strategies to help develop understanding and recall. These are key study skills and will be particularly useful strategies for students in revision.

Skill Area 4 Visual representation

Scientists customarily process the findings they have collected and the conclusions they draw into various kinds of visuals. Visual representations help students to link information into logical continuums. Focusing on the extensive content and diverse forms of visual representations in science can help understanding of texts that require complex, deep and abstract thinking.

Skill Area 5 Scientific writing

In the Post-16 environment, students are frequently expected to produce extended pieces of writing. Scientific writing may not have been developed at GCSE, so this needs explicit teaching and developing. Some of the more challenging activities require scaffolding, or should be attempted later on in the course. One activity within this Skill Area also tackles issues of plagiarism.

Skill Area 6 Knowledge presentation

In the scientific community, knowledge is presented in lectures and at conferences by oral presentation, and through visual means such as scientific posters. This Skill Area introduces students to ways in which they can present their knowledge orally and visually in a similar way to professional scientists.