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SCIENCE FOCUS: THE SALTER'S APPROACH

Abstract

Science Focus The Salters' approach to the teaching and learning of science at the Junior Secondary level is outlined by showing how the phenomenon of fire is treated in the curriculum materials. The contents of the teachers' guide, the student texts, and the assessment pack are discussed and an evaluation given of the usefulness of the approach in the Australian context.

Introduction

Judith Ramsden (1992) recently introduced the readers of this journal to the Salters' approach by illustrating how science units were constructed for Years 10 and 11 secondary science. The Salters' Science Course, developed by the University of York Science Education Group, was designed to satisfy the following criteria (Campbell, Lazonby, Millar, Nicolson, Ramsden & Waddington, 1994):

It should have its origins, and hence its justification for study, in aspects of everyday life with which students aged 11-16 will be familiar either personally or through the media.

Scientific concepts and explanations should arise naturally from the study of these everyday situations and should only be introduced when they are needed. Social, economic, environmental, industrial and technological aspects of science are, therefore, fundamental to the whole course.

The purpose of this article is to report on the development of science units for the younger secondary students of ages 11-13 (Years 7, 8, and 9) and to illustrate how the Salters' approach has been applied to the phenomenon of fire. It is also intended to outline the potential benefits of using such an approach. The science course for Years 7-9 is called Science Focus and comprises 27 units which are listed in Figure 1.

Curriculum materials

Science Focus curriculum materials include teachers' guides, student texts and assessment packs. These are described for the unit Fire-Friend and Foe.

The teachers' guide

There is one teachers' guide for each year of work. The teachers' guide is built around five work plans (about seven lessons) in the case of the fire unit. These plans are specific enough to be suitable for the inexperienced teacher or teacher working outside their own scientific discipline but flexible enough to allow experienced teachers to introduce replacements and modifications to them where it is deemed desirable. The plans for the fire unit are summarised in Figure 2 and give a summary of the content of the unit. The teachers' guide provides an outline of the type of activities for a lesson, the key points, a summary of the equipment required, a brief description of one way to use the resources in student texts, hints on practical work, answers to questions, and other pieces of information which are of immediate use to the teacher.

The student texts

There are two student texts for each year of work. Both textbooks are very slim by textbook standards and are designed to support the teacher's work. Looking into Science is in full-colour and has photographs and activities relating to each unit and to the scientific ideas and their applications. In the case of the fire unit, controlled and uncontrolled fires are illustrated with photographs and the need to use different extinguishers for different types of fires is emphasised through accompanying questions and illustrations.

In Working with Science, there are a range of activities for students which help to reinforce their understanding of the scientific principles. These activities include laboratory -based practical work, data interpretation, directed activity related to a text, translating data from numerical to graphical form, quiz sheets, and questions related to teacher demonstrations. I will illustrate how two of these activities are used in the fire unit: data interpretation, and directed activity related to a text. Early on, students are asked to interpret published statistical data on fires to answer questions such as, How does a fire start?, Where are fires most likely to occur?, and What type of fire causes the most deaths? In this lesson they do an experiment to introduce the fire triangle and finally they are asked to design a safety leaflet using the fire triangle to explain how fires in the

laboratory can be extinguished. Later in the unit, a directed activity related to a newspaper report about a disco fire is given. The activity is reproduced in Figure 3. To cope adequately with this activity students need to have understood the following concepts introduced in earlier lessons: the fire triangle (fuel, heat, oxygen) required to start a fire, the effect of flame spreading and the very high level of heat radiation thus produced, and the effect of the rapid spread of smoke after hitting a cooler surface. All these concepts were introduced through either data interpretation, laboratory-based practical work, or teacher demonstrations in earlier lessons.

The assessment pack

There is one assessment pack for each year of the course which supports the multitude of questions asked in the student texts. These packs provide the following for each unit of the course: a photocopiable In Brief which summarises the key points of the unit in a visually interesting way (see Figure 4), and a set of questions and answers designed to test the students' grasp of these key points (see Figure 5 for a sample of questions). Although the In Brief and the questions make use of interesting contexts, they do emphasise the key scientific ideas covered in the unit.

An evaluation of the Salters' approach

Many science courses typically use everyday illustrations to support key scientific concepts being taught; the curriculum is organised around science concepts, not everyday phenomena. In many curricula, "fire" is not studied in any detail at all and any mention of it usually occurs as illustrations of science concepts in chapters associated with concepts of heat, energy, combustion or gases. The Salters' approach, however, uses an everyday phenomenon as the central focus and employs scientific concepts to support an understanding of the phenomenon, The lesson titles shown in Figure 2, for example, illustrate that the key points in each lesson relate to fire, not to energy, oxygen, carbon dioxide, or other chemical terms. These concepts support an understanding of the phenomenon of fire as illustrated in Figure 6. As one moves out from the phenomenon of fire in Figure 6, the terms gradually become more scientific in terms of the language and concept structure.

It has been argued, on occasions, that an approach that centralises everyday phenomena rather than science in its curriculum methodology reduces the amount of science being taught compared with some other courses. While there may be some justification for this argument for some areas of science, and this is still debatable, the claim can be made that in the Salters' approach the science studied is highly relevant and meaningful, because it is learnt not as isolated scientific fact but as a tool for understanding important phenomena in the everyday experience of the young student. This means that the science studied is anchored to meaning and, on occasions, ideas from across a range of the disciplines are required to bring understanding to the phenomenon in question. An enhanced understanding of the science involved may result. For example, an analysis of fire death statistics helps the student to locate what is likely to cause death in a fire. In addition, addressing fundamental questions like, What is a flame?, What causes a flame?, What happens when something burns?, may result in an enhanced understanding of the

chemistry of fire. Very few science courses, for example, illustrate that in order for a fuel to burn with a flame it must first be converted to the vapour state. This is a key idea established in the third section of the unit (Figure 2).

Practising classroom teachers' craft knowledge about teaching and learning was drawn upon right from the planning stages of the Salters' units. Consequently, teachers will find all the Salters' materials user-friendly and adaptable because they reflect their experience. Also, a large variety of activities is provided in the units to enhance students' active engagement with the materials. Many of the units are suitable for Australian classrooms but teachers may find it advantageous to use Australian data in preference to UK data in some of the activities. The units have this built-in flexibility for change where required.

Conclusion

The Salters' approach is an exciting way of teaching and learning science and also provides a good basis for students proceeding further in their science studies. The units are self-contained and teachers may find it useful to incorporate a subset of the 27 unit titles into their current science course if they prefer not to adopt the whole of the Science Focus program. However, if you are anxious to engender more interest and activity in the teaching and learning of science at the junior secondary level, the Salters' approach could be your answer. More information can be obtained by contacting your local Heinemann representative or the University of York Science Education Group, University of York, Heslington, YO1 5DD, England.

Acknowledgment

The author would like to thank the University of York Science Education Group for permission to use the diagrams and information shown here in Figures 3,4 and 5 taken from the published Science Focus materials and Professor David Waddington for his helpful suggestions and comments.

PHOTO (BLACK & WHITE): Kevin de Berg

Figure 1. Seeing stars

Science Focus:The 27 titles for Years 7-9

Year 7	Year 8	Year 9
Introduction	Body care	Current thinking
Skin deep	Conditions for life	Drinks
Having babies	Full of beans	Food
Neighbours	Fire: friend or foe	Green machine
Paper chain	On the rocks	Growing up
Out of this word	Wear and tear	Metals
Switching on	Child's play	Safe journey
Making sense of it	Music and noise	Safe as houses
	Seeing the light	Word watch

Figure 2. Overall plan for the fire unit

Overall Plan

Section 1 (1 lesson) How do fires start?.

Through the examination of statistical data and by carrying out experiments, students learn about the different parts of the fire triangle. They discuss how to carry out safely experiments involving burning.

Section 2 (2 lessons) Heating homes

This section deals with the range of fuels which are in use, and factors which influence heating costs. In addition to data search and interpretation activities, students also design and use a questionnaire survey.

Section 3 (1 lesson) Controlling flame

In this section, students carry out a series of experiments to help them construct a theoretical model of how fuels burn.

Section 4 (1-2lessons) What happens when something burns?

This section begins with further work on the candle, this time considering the products of combustion. They then consider information about aspects of atmospheric pollution, and end the section with some creative writing.

Section 5 (1 lesson) Fighting fires

Students use text activities and practical tests on the effects of fire on common materials to consider the dangers of fires which get out of control.

Figure 3. Student activity related to a newspaper report of a disco fire

A lucky escape

Last week a disco in the centre of town was destroyed by fire. Luckily, nobody was seriously hurt.

Read this newspaper extract and look carefully at the plans of the disco. Use what you have learned about fires to help you to answer the questions

Disco fire

75 young People Were rescued from a blazing inferno when the Zig-Zag disco Caught fire at 10 p.m. last night.

No one knows Why the fire started but the bar manager said she saw the fire spread quickly from the seating area to fill the disco with flames and choking smoke.

Most of the young People Were able to get out by Using the emergency exit. Once the emergency doors had been opened, the intensity of the blaze increased dramatically, and firefighters Were unable to prevent the building from being completely burned out

Some people Were later treated for minor burns and the effects of toxic fumes.

The fire started at point A in the seating area. Suggest how the fire might have started.
Why do you think the fire spread so quickly to the rest of the disco?
Why do you think the people on the dance floor did not suffer too much from the effects of smoke and fumes?
What do you think may have been the cause of the toxic fumes?
Why do you think the fire spread more quickly when the emergency doors were opened?
If the disco were to be rebuilt, what improvements might you make to:
make a fire less likely
reduce the damage caused by fire?
ILLUSTRATION: Figure 4: The 'Brief' summary of the fire unit from the assessment pack

In Brief

Fuel, heat and oxygen are needed for burning

These three factors are known as the life triangle.

• Check that you can use this fire triangle to explain how fire extinguishers work.

Burning is a chemical reaction which produces heating.

In a chemical reaction new products are formed.

Most fuels contain carbon and hydrogen. When they burn in plenty of air, carbon dioxide and water vapour are formed.

Chemical reactions can be written in the form of word equations.

• Try to complete this word equation:

hydrocarbon + oxygen

We need sources of energy to heat our homes and our water supply, and to cook our food.

Fire occurs when substances burn.

The temperature at which a fuel produces enough vapour to allow it to ignite is called its flashpoint.

House fires produce heating, smoke and toxic gases which rise by convection.

Even though the use of electricity in the home does not involve burning a fuel, most power stations burn fuel.

Coal and oil are fossil fuels formed when the remains of plants and marine animals were buried in sediments.

Coal and oil are non-renewable resources.

Many fuels contain sulphur impurities which burn to form sulphur dioxide.

Energy-saving features such as roof lagging, cavity wall insulation and draught excluders can reduce energy losses and fuel bills.

Energy can be transferred by conduction, convention and radiation

What type of energy transfer does each type of insulation reduce?

Figure 5. Sample questions from the assessment pack

Unit Test

(a) Name the three parts of the 'fire triangle' that are needed in order to start a fire.

(b) If someone's clothes catch fire, one way to put out the fire is to wrap the person in a fire blanket. Which part of the fire triangle is taken away by using the blanket.?

Some camping stoves use butane as their fuel. Butane normally boils at 0 degrees C, but the butane stored in canisters has been compressed to turn it into a liquid.

(a) What is an advantage of storing butane as a liquid?

(b) Why might a butane stove be difficult to light on a very cold day when the temperature is below 0 degrees C?

Butane is a compound of carbon and hydrogen. When butane bums in plenty of air, it burns completely and produces only harmless substances. But a badly maintained butane stove can be dangerous because the butane may not mix with enough air to bum completely.

(c) Write a word equation to show what happens when butane bums completely.

(d) Name a dangerous substance that could be made by butane burning incompletely.

3 This information is from a magazine article about the environment. Read it carefully and then answer the questions that follow.

(a) Write a sentence to say how burning coal pollutes the air.

(b) Explain why using electricity causes pollution.

(c) Write one or two sentences to describe how coal and oil are formed and explain why coal and oil are called 'non-renewable' resources.

Forty years ago, coal fires made the air in towns very dirty. In the 1950s there were several very bad fogs in cities, and the government made laws against burning 'dirty' fuels in towns. Nowadays, many people heat their homes by electricity. The air in towns is cleaner, but we must not forget that using electricity also causes pollution. We can't do without burning fuels at all - the energy to make electricity has to come from somewhere!

One simple thing we can do to help the environment is insulate our homes. If we can cut down the amount of energy that is wasted, we will not only save money on our heating bills, but the less fuel is burned, the less pollution there will be - and we will also save precious non-renewable resources like coal and oil.

ILLUSTRATION: Figure 6. Model showing scientific concepts supporting the central phenomenon of fire.

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