

No. 219 Winter '06 Contents

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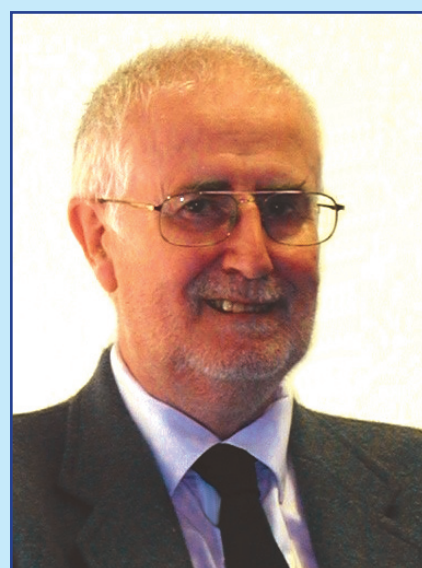
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Councillor David McGrouther BA JP - an appreciation

In September of this year, after well over twenty years in the Chair of SSERC, Councillor David L. McGrouther intimated his decision to resign from the Board of SSERC Limited. David is also stepping down next year from West Lothian Council and will not be standing for re-election. He has stayed in the chair at SSERC long enough to see the Centre settled in a new home in Fife before tendering his resignation.

This is typical of the man and perhaps that is how SSERC staff and his fellow Directors on the Board might best remember David – as a stayer and a finisher. He came to the chair of SSERC (when it had a Governing Body rather than a Board) almost by accident one might say. At the time of his first appointment as a Governor he was a senior Lothian Regional Councillor. On the occasion of his first scheduled meeting he had another prior and pressing engagement. Thus he found himself victim of that established tradition whereby all non-volunteers learn to step smartly backwards. He was duly elected to the chair in absentia.

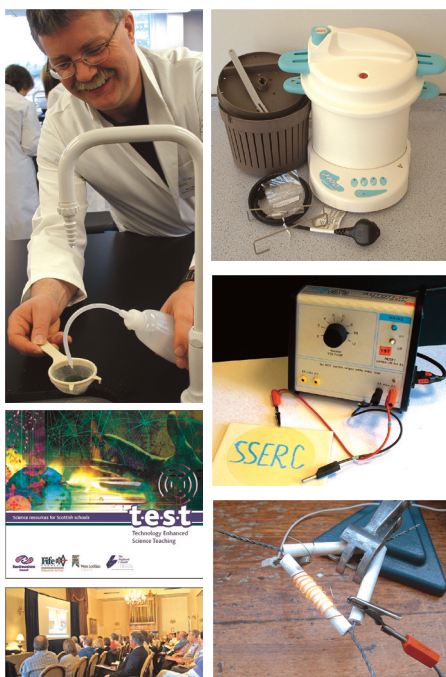


Even though he was then vice-convenor of Lothian's Education Committee, and therefore always extremely busy, David never failed to find the time for SSERC business. This is all the more remarkable when one considers that his professional and academic background lies in the humanities and not the sciences. One of his greatest contributions, undoubtedly, was to stand by and actively campaign for SSERC at the time of local government disorganisation and the split into 32 councils from 12. For many local authority politicians, it might well have been more expedient simply to let SSERC slide into insolvency and go under. Instead, he took a deep breath, SSERC stopped trading for a while and thus remained solvent. With assistance from David and using his heavyweight political clout we got sorted out, re-jigged our finances and used that breathing space to recruit the new councils into membership.

David could have stepped down at that point and taken a lot of credit for SSERC's survival. That he went on and has stuck with the organisation, seen it grow and then re-locate to excellent premises on the other side of the Forth speaks volumes about the man and his unswerving commitment to science and technology education.

Not bad for a non-scientist!

We wish David and his wife Fiona all the very best for the future and for a long and happy retirement.



SAPS Photosynthesis Kit : the use of algal balls to investigate photosynthesis

Introduction

The use of immobilised algae and hydrogencarbonate indicator provides an engaging and interesting approach to practical work that supports the learning and teaching of photosynthesis in the school laboratory. The technique was developed by Debbie Eldridge¹ from King Ecgbert School, Sheffield while working on a SAPS/Robinson College Schoolteacher Fellowship. SAPS has now produced a *Photosynthesis Practical Kit* based upon Debbie's work. This article describes briefly the kit and some of its possible uses in the classroom.

A new technique

Traditional practical work in photosynthesis focusses on testing the products of photosynthesis, either by monitoring the evolution of bubbles containing oxygen in *Elodea* or using iodine to test for starch in geranium leaves that have been decolourised. Standardisation of the quantity of photosynthetic material under test is difficult and quantification of the starch is impossible using standard classroom procedures. Using these methods, it has been very difficult to carry out investigative work on the rates of photosynthesis and students rarely find the work stimulating. The *Cabomba* plant techniques shown in *Bulletin 215*, also developed by Debbie Eldridge, can give more reliable results than with the traditional *Elodea* :-

<http://www.sserc.org.uk/members/SafetyNet/bulls/215/Biology.htm>

Algae can be considered as single-celled plants. They can be grown easily, concentrated, and then, using immobilisation techniques, divided into standard quantities in the form of so-called algal balls. These algal balls can be easily manipulated and, in association with hydrogencarbonate indicator, used in practical investigations of photosynthesis. The hydrogencarbonate indicator will change colour according to the concentration of dissolved carbon dioxide (CO₂). The concentration of dissolved CO₂ will be governed by the balance of photosynthesis and respiration. The colour changes in the hydrogencarbonate indicator can be quantified either by measuring the absorbance of the indicator at 550 nm with a colorimeter or by comparing the colours with a set of standard buffer solutions :-

<http://www-saps.plantsci.cam.ac.uk/work-sheets/ssheets/ssheet23.htm>

¹ Eldridge, Debbie (2004). A novel approach to photosynthesis practicals. *School Science Review*, 85 (312), 37-45



Figure 2 - SAPS Photosynthesis Kit

The SAPS Photosynthesis Kit (Fig. 2) contains algae (*Scenedesmus quadricauda*); enrichment medium for growing up the algae; sodium alginate for immobilising the algae; syringes for creating appropriately- and evenly-sized drops that can form jelly balls; hydrogencarbonate indicator in a concentrated form; Bijou bottles (Figure 1) for carrying out the reactions; and coloured filters that can be used in investigations of wavelength of light on photosynthesis. The school has to supply a vessel for growing the algae, such as a large lemonade bottle; a simple air pump such as that used in a fish tank to aerate the growing culture; illumination for growing the culture (a lightbank is useful, here); clamps and stands to hold the syringes; plastic cups and spoons for mixing the algae with alginate and for holding calcium chloride solution; 2% calcium chloride solution; tea strainers; lamps for experimental work. The kit contains full instructions for growing the algae, for producing algal balls and suggestions for experimental work.

Growing the algae

The kit contains a small bottle of the alga, *Scenedesmus quadricauda* and concentrated enrichment medium. The algae need to be grown in diluted enrichment medium for 3 – 4 weeks in order to produce enough algae for a 'class set'. Full instructions for inoculation and growth of the algae are contained within the kit.

Making the algal balls

To make the algal balls, algae are mixed with sodium alginate solution and this mixture is then allowed to drip gently into calcium chloride solution. This forms jelly balls of calcium alginate with algae



trapped inside i.e. this process immobilises the algae.

The powdered sodium alginate provided with the kit needs to be dissolved in water to make the 2-3% solution required.

Figure 1 - Immobilised algae in hydrogen-carbonate indicator

Sodium alginate can take some time to dissolve and so it is recommended that it be made up at least 24 hours before the class practical work is due to take place. It is important not to heat the sodium alginate as this would be likely to affect the consistency of the algal balls. A 2% calcium chloride solution is also required.

The algal culture that has been grown needs to be dispensed (about 50 cm³ per student or group) and concentrated. Concentration of the algae is achieved either by leaving them to stand (Figure 3) or by centrifuging.

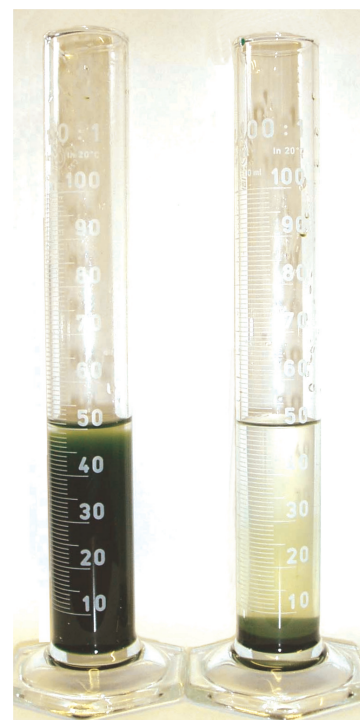


Figure 3 - Concentrating the algae

On discarding the supernatant, a much-reduced volume of concentrated algae remains. Approximately 3 cm³ of this concentrated algae is mixed (Figure 4) with an equal volume of sodium alginate solution in a clean vessel such as a universal container. This mixture is added to the syringe and then allowed to drip gently into the calcium chloride solution (Figure 5). The syringes supplied with the kit have long, narrow nozzles that are particularly well suited to producing

fairly small, uniformly-shaped and sized algal balls. The calcium chloride solution should be swirled gently as the algae drop into it. The result is the formation of balls of calcium alginate of uniform size and containing approximately equal quantities of algae.

The algal balls should be left for approximately five minutes to harden, washed in tap water (a tea strainer is useful to hold the algal balls (Figure 6)) and then given a final rinse with distilled water. These



Figure 4 - Mixing algae and alginate

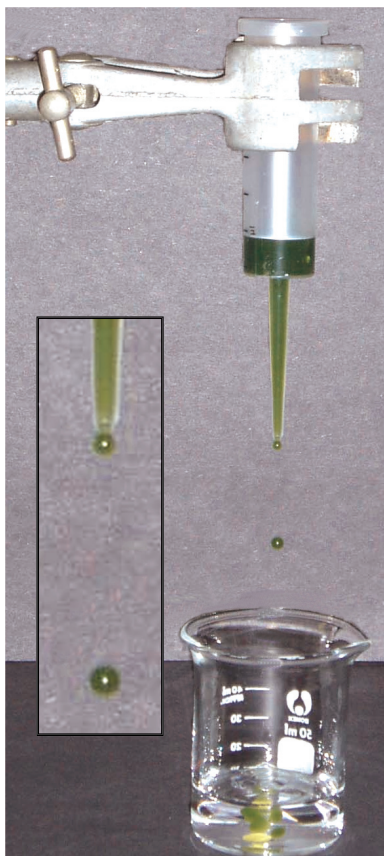


Figure 5 - Forming the algal balls

rinsing steps are required to ensure that all the calcium chloride is completely removed. At this stage, the balls can be kept refrigerated under distilled water for up to six months. When ready to carry out experimental work, the balls can then be counted out (Figure 7) and added to hydrogencarbonate indicator.



Figure 6 - Washing algal balls in tea strainer



Figure 7 - Counting algal balls

Hydrogencarbonate indicator

Hydrogencarbonate indicator is very sensitive to changes in pH and hence to dissolved carbon dioxide level. The indicator is orange/red when the dissolved carbon dioxide concentration is in equilibrium with air. It changes through orange to yellow as the pH falls, i.e. as carbon dioxide concentration increases (for example when the rate of respiration exceeds the rate of photosynthesis). When the

carbon dioxide level falls, the hydrogencarbonate indicator changes through red to a deep purple (for example, when the rate of photosynthesis exceeds the rate of respiration). The colour of the hydrogencarbonate indicator can thus be used to monitor both respiration and photosynthesis. The colour change can be measured either by using a colorimeter to measure absorbance at 550 nm or by comparing with a set of standard buffer solutions (Figure 8).

250 cm³ hydrogencarbonate indicator is provided with the kit. It needs to be diluted 10x for use. Because of its sensitivity to changes in pH, it is essential that all glassware etc. is rinsed out with a little indicator before use. Due to variations in commercially prepared hydrogencarbonate indicator, SAPS recommends that any additional solution required is prepared according to the instructions provided with the kit.

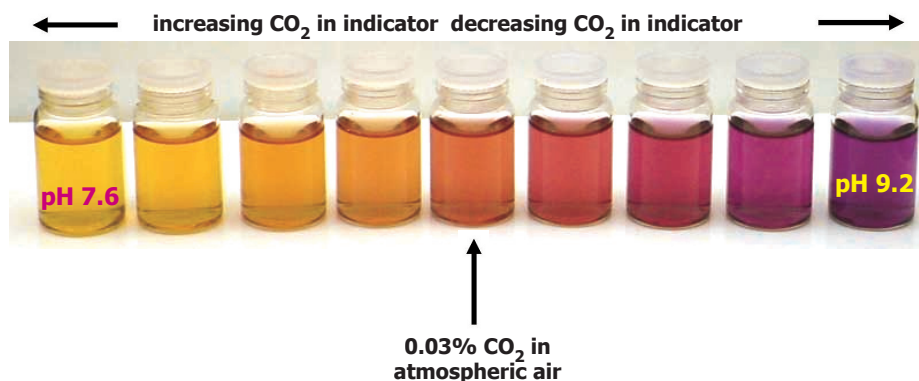


Figure 8 - Colour chart for hydrogencarbonate indicator in standard buffer solutions from pH 7.6 – pH 9.2 at 0.2 increments

Light sources

The light source needs to be stronger than a standard 40 W bench lamp. SAPS recommends two types of light source:



Figure 9 - 150 W lamp

1. Halogen lamps such as the one shown in Fig. 9 are typically rated at 150 W. They, therefore, give out a lot of heat and so a heat filter should be employed when using them as a light source for experiments on photosynthesis. A good heat filter might simply be a medical flat bottle filled with water placed between the lamp and the algal balls.

2. Fluorescent tubes do not give out as much heat and therefore do not require a heat filter. As it is easier to measure the distance between sample and lamp (Figure 10), more samples can be used with a single fluorescent tube, therefore reducing the effects of variability in the light source.

We have found fluorescent tubes more convenient to use and that they provide very satisfactory results.

Experiments using the algal balls

Whilst the instruction set for making the algal balls is quite prescriptive, the use of the algal balls themselves allows a range of open-ended investigations and provides students with an opportunity to plan and carry out their own investigations. Algal balls and a standard volume of hydrogencarbonate indicator should be added to the Bijou bottles that are provided with the kit. As the algae absorb CO₂ from or release CO₂ into the hydrogencarbonate indicator, it changes colour. This set-up can be used to investigate a number of variable factors that affect the rate of photosynthesis. In the next section we look at how to examine the effects of changing light intensity and wavelength as well as how the quantity and type of algae can affect the rate of photosynthesis.

Light intensity

The effect of light intensity on the rate of photosynthesis in algal balls can be approached in two ways:

1. Bijou bottles containing a standard quantity of algal balls and hydrogencarbonate indicator can be placed at different distances from the lamp and the rate of change of colour monitored and recorded. The hydrogencarbonate indicator

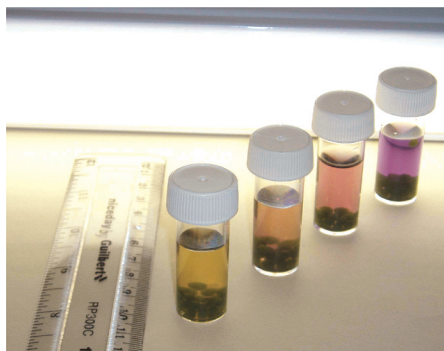


Figure 10 - Algal balls at varying distances from the light source (in this case, a fluorescent tube)

changes colour from orange through red to purple most rapidly in the Bijou bottle closest to the light source. The algal balls contained therein are carrying out photosynthesis at a faster rate than those in the Bijou bottles at a greater distance from the light source, the concentration of the CO₂ reduces more rapidly and a colour change is observed. Care must be taken that the bottles closer to the light source do not obscure the bottles further away.

2. The Bijou bottles can be covered with different neutral density filters. Neutral density filters are 'grey' filters and five different such filters are provided with the kit. An ideal neutral density filter would reduce the intensity of light of all wavelengths equally. In practice, neutral density filters do not achieve this. Each of the filters provided in the SAPS Photosynthesis Kit does reduce the intensity of light reasonably evenly across the range 400–660 nm. The names and the notional amount of light transmitted in the spectral range 400-660 nm by each of the neutral density filters is summarised in the Table 1 below.

Using these neutral density filters as an alternative to varying the distance of the Bijou bottles from the light source reduces possible sources of error that might arise from:

- changes in light intensity which arise from a change in angle between the lamp and sample
- difficulties in interpretation and application of the inverse square law which governs the relationship between light intensity and distance from the light source
- any heating effects caused by varying distances from the lamp.

Filter name	298 (0.15 ND)	209 (0.30 ND)	210 (0.6 ND)	211 (0.9 ND)	299 (1.2 ND)
Light transmitted (%)	71	50	25	12.5	6.3

Table 1 - Names and the notional amount of light transmitted in the spectral range 400-660 nm by each of the neutral density filters.

Wavelength of light

The effect of wavelength of light on the rate of photosynthesis in algal balls can be investigated using filters of different colour (Figure 11). In addition to the five neutral density filters, the kit provides nine coloured filters. These can be wrapped around the Bijou bottles and provide a straightforward way of altering the wavelength of light reaching the algal balls within. The rate of photosynthesis in each of the bottles can be compared by observing changes in the colour of the hydrogencarbonate indicator.

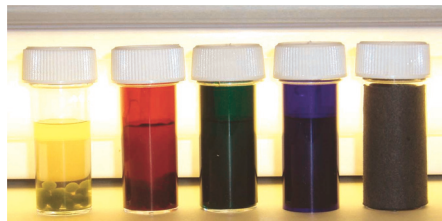


Figure 11 - Algal balls and hydrogencarbonate indicator in Bijou bottles covered with coloured filters

More information on the filters and their uses in these practicals is provided on the SAPS website:

http://www-saps.plantsci.cam.ac.uk/articles/broad_light.htm

Quantity of algae

The effect of numbers of algae on the rate of photosynthesis can be achieved in two ways:

- 1.** The number of algal balls used with a standard volume of hydrogencarbonate indicator can be varied.
- 2.** The concentrated algae produced from settling or centrifuging can be diluted and the different dilutions used to make algal balls that contain different numbers of algae. In this case, equal numbers of balls should be added to the standard volume of hydrogencarbonate indicator.

Type of algae

The rates of photosynthesis carried out by different algae can be investigated if different algae are grown up and immobilised. The concentration of algae can be quantified using a haemocytometer and so the rates of photosynthesis by similar concentrations of algae under given conditions can be compared. Guidelines for using a haemocytometer can be found on the SSERC website in the Microbiological Techniques section of SafetyNet :-

<http://www.sserc.org.uk/members/SafetyNet/Microbio2/EM/countcells.htm>

Equivalent concentrations of algae, however, do not necessarily contain equal concentrations of chlorophyll and it would be difficult to ensure that the quantity of photosynthetic pigment for each organism is standard. It would, however, be possible to investigate, qualitatively, whether blue-greens photosynthesise optimally at a different wavelength of light from standard algae. At SSERC, we have successfully grown *Scenedesmus quadricauda*, *Chlorella sp.* (both algae) and *Cynechoccus sp* (Cyanobacteria or blue-greens).

Appraisal of the kit

Using the SAPS Photosynthesis Kit makes the implementation of practical work with algal balls in the classroom easy. Any materials not supplied in the kit are readily available in schools. Students enjoy making and working with algal balls (Figure 12). They can plan practical work for use with algal balls and investigate a range of factors on the rate of photosynthesis, by observing colour changes caused by differences in levels of CO₂.



Figure 12 - Cheers! Success at making algal balls.

The kit is provided in a plastic box and brings together some equipment that is not normally available in school laboratories and apparatus whose design has been found to be particularly useful for investigations with algal balls. It also makes available, in quantities practicable for school use, materials that are available for bulk purchase (for example the filters and the Bijou bottles). At £37.50, including postage and packing (£30.00 without P & P), the cost of the kit is significantly less than the sum that would

have to be expended on similar quantities of materials and has the advantage that the principal resources are to hand. The syringes, Bijou bottles and filters are reusable. Details of where to purchase replacement consumables for the practical work are included with the kit. Additional materials required for the practical work are commonplace in schools. The kit provides hardware sufficient for fifteen students or groups to carry out work at one time. However, there is sufficient medium, alginate, hydrogencarbonate indicator and algae when cultured to allow 45 sets of experimental work. Hence the materials within a single Photosynthesis Kit could support 3 x 15 sets of practical work over a short time period. The hardware would, of course, be available for subsequent occasions with only the consumables requiring to be purchased. We consider that the SAPS Photosynthesis Kit represents very good value and is an excellent resource.

Further information and purchases can be obtained from:

SAPS, Homerton College, Hills Road, Cambridge CB2 8PH, Tel: 01223 507168 ; email saps@homerton.cam.ac.uk

Revisiting useful friends - now even cheaper

An opportunity has arisen which may benefit microbiology work carried out in schools. This has been made possible through collaboration with Scientific & Chemical Supplies Ltd. and Prestige Medical.

Here we announce an exclusive offer in Scotland where you can purchase an autoclave which we have found to be ideal for use in schools. At SSERC we evaluate equipment received from suppliers to ensure safety and suitability for school use. The Classic 2100 met all criteria regarding pressurised systems (BS3970: Part 4). The results of our tests are available in full detail on the Members part of the SSERC web site (SafetyNet-What's New).

The Model 2100 Classic, which has the Standard Body, can operate at 126 °C for 11 mins. The Extended Body version operates at 121 °C for 15 mins and is specially designed for media. It has temperature and pressure gauges and a thermal jacket. Both models come with instrument tray, basket, lifter and 'V' support. Both standard and extended body versions can be purchased through Scientific & Chemical by quoting the catalogue numbers shown in Table 1 and offer savings of £200 and £300 respectively over the normal catalogue prices.

Contact Scientific & Chemical Supplies Ltd, 39 Back Sneddon Street, Paisley, Renfrewshire PA3 2DE

Telephone: 0141 1887 3531 E Mail: paisley@scichem.com



Figure 1 - Standard Body autoclave at new price of £465

Catalogue No.	Description	Old Price	New Price
AUT 010 015	Standard Body	£678.57	£465
AUT 010 055	Extended Body 'Plus' Media	£959.18	£640

Table 1 - Standard Body autoclave at new price of £465

"These models provide effective steam sterilisation for educational microbiological work. Prestige Medical autoclaves are easy and convenient to use for both sterilising most media and disposal of microbiological waste. The taller model with the extended body is particularly useful."

SSERC Bulletin 216, Spring 2006

Equilibrium and Le Châtelier

Introduction

The effect of temperature on the position of an equilibrium can easily be seen by observing the colour changes of the octahedral hexaaquacobalt(II) cation and the tetrahedral tetrachlorocobaltate(II) anion as the sample is moved from a low temperature to a high temperature.

What you will need

Chemicals

cobalt(II) chloride
 industrial methylated spirits (IMS, clear)
 distilled water
 hydrochloric acid (concentrated)

Equipment

balance
 spatula
 weighing boat
 measuring cylinder, 100 cm³
 beaker, 250 cm³
 beaker of iced water, 100 cm³
 water bath at 50°C (or beaker of hot water and a thermometer)
 measuring cylinder, 10 cm³ or bulb pipette
 test tube
 hair dryer
 polystyrene, small square with hole cut in it (diameter of the test tube)

Preparation of the solution

Prepare a solution of the cobalt salt in the large beaker by dissolving 2 g in 100 cm³ of IMS and 20 cm³ distilled water.

Place 20 cm³ of the solution in the test tube.

Place this in the water bath and bring it up to the required temperature of 50°C.

Using the measuring cylinder or bulb pipette, carefully add 2 cm³ of the concentrated hydrochloric acid to the solution. It will turn from pink to blue.

Allow the solution to cool to room temperature. It should turn mauve in colour.

The equilibrium equation can be expressed as follows:

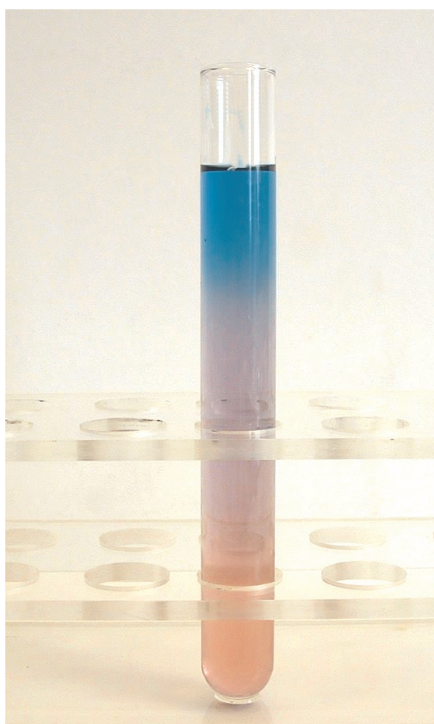
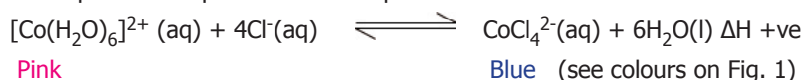


Figure 1 - Thermochromic gradation

The demonstration

Fill the test tube with the cooled solution.

Place the polystyrene collar about a third of the way down the test tube.

Place the test tube in the beaker of iced water to a depth of about a third its length.

At the same time use the hair dryer to heat the top third of the solution above the polystyrene (this to stop the middle third of the test tube heating up).

Observe the colour changes (Fig. 1)!

If desired, test tubes of the solution can be prepared for students to carry out the experiment for themselves.

If they are given the equilibrium equation and the colours of the ions in solution, their observations of the colours at low and higher temperatures can lead them to predict if the sign of ΔH for the forward or reverse reaction is positive or negative.



Figure 2 - Using hairdryer used to heat upper half of test tube

Chemical	Main Hazard	Control Measures
Cobalt(II) chloride	Category 2 carcinogen by inhalation. Sensitiser by skin contact.	Avoid raising dust. Wear eye protection and gloves to prepare solution from the powder.
Hydrochloric acid (concentrated)	Extremely irritant and corrosive vapour. Liquid and vapour causes severe burns to eyes, lungs and skin.	Wear nitrile gloves/gauntlets and eye protection. Fuming hydrochloric acid should only be handled in a fume cupboard.

Curricular references

Higher Chemistry, Unit 3, Chemical Reactions, (c) - the concept of dynamic equilibrium and shifting the equilibrium position.

Advanced Higher Chemistry, Unit 2: Principles of Chemical Reactions, (b) Chemical equilibrium.

Electric writing

Introduction

This demonstration resurfaced when we were in the process of clearing out old paperwork, prior to our move from Edinburgh to Fife. It had originally been done by one of our Senior Associates in 1988! Here we gave it a slight twist by changing the solution and the electrode used as the pen. It generated a great deal of interest when displayed at the National Chemistry Teachers' Conference in St. Andrews. Ah - the old ones are still the best!

It can be used for S1/S2 in *Changing Materials, Level E* to show changes in appearance in chemical reactions and in Standard Grade, and Intermediate 1 and 2 to show chemical reactions. It also makes an eye-catching experiment for an open-evening/parents' night.

What you will need

Chemicals

potassium chloride, 1M solution
(3.725g/50 cm³ of solution)

bromothymol blue indicator solution

Equipment

atomiser spray bottle, 60 cm³
filter paper
white tile
d.c. supply, low voltage
2 x leads (one with a crocodile clip, the other with a 4 mm jack plug)
hair dryer
gloves, disposable
eye protection (goggles)

The demonstration

Place 6 cm³ of the indicator in the atomiser and top up with 50 cm³ of potassium chloride solution.

Label as *electric ink*. This has prompted many a question as to its composition!

Place the filter paper on the white tile and connect it via the crocodile clip to the low voltage supply (set at 10 V dc) as shown in Fig. 1 with the *pen* connected to the negative electrode (cathode).

Spray the filter paper with the potassium chloride/indicator mixture until it goes a pale yellow colour. The paper will have been bleached previously by an acidic solution. Hence the yellow colour of the indicator.

The paper should be quite wet but not so the solution is running off it.

Switch on the power supply and use

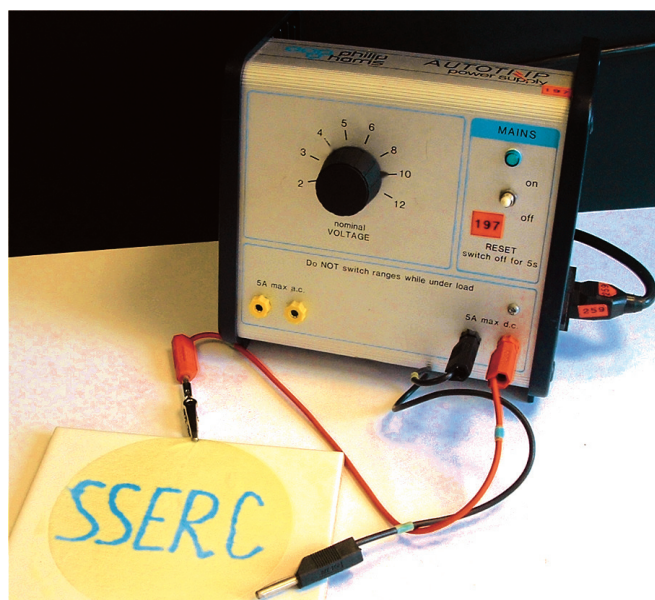


Figure 1 - Apparatus for electric writing

the *electric pen* (4 mm plug) to write a message on the wet filter paper. Dry the paper and watch the message fade away. Spray with distilled water and it magically reappears.

What makes it happen?

Water molecules in the solution are reduced at the black 4 mm plug (cathode, -ve) producing hydroxyl ions making the solution near to the *pen* alkaline. The resulting colour change in the indicator is from yellow to blue.

Various adaptations are possible :-

(a) Replace the bromo-thymol blue indicator with phenolphthalein and the message appears in pink.

It can be dried to make it fade and re-sprayed with water to make it reappear as before.



Figure 2 - with phenolphthalein

(b) Duplicate the original experiment by replacing the 1M potassium chloride solution with 1M potassium iodide solution but with no indicator. Change the electrodes round so the 4 mm plug *pen* is connected to the positive terminal of the power supply and the crocodile clip to the negative.

Now when a message is written by the *pen* the iodide ions are oxidised to iodine molecules and the message appears brown.

(c) Add 10 cm³ of a 1% starch solution to 50 cm³ of the 1M potassium iodide solution and the message appears blue/black due to the reaction of the iodine molecules with the starch.

Suggestion: have all four experiments available to pupils to stimulate discussion of the different colours.



Figure 3 - with iodine



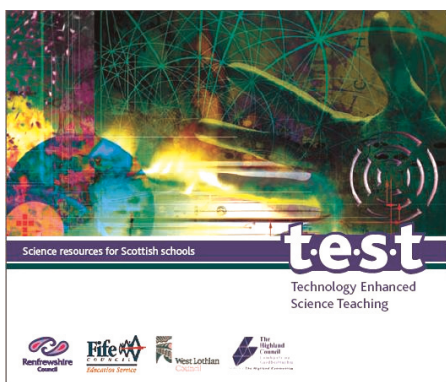
Figure 4 - with starch/iodine

Chemical	Main Hazard	Control Measures
Bromo-thymol blue	HARMFUL if ingested in quantity or inhaled as dust. FLAMMABLE solution.	Avoid raising dust. Wear eye protection and ensure ignition sources are absent.
Phenolphthalein	HARMFUL by ingestion. IRRITANT to eyes and respiratory system. FLAMMABLE solution.	Avoid raising dust. Wear eye protection and ensure ignition sources are absent.

Table 1 - Safety measures

CPD Update: ISE 5-14 through CPD draws to a close

Technology Enhanced Science Teaching (TEST) DVD



The launch of the TEST DVD at SETT in September was a major tangible outcome of the fifth and final consortium in the Improving Science Education 5–14 through CPD (ISE 5-14) initiative. The TEST DVD contains a wide variety of high quality exemplar and interactive CPD activities for the three science attainment outcomes. The partners in the collaborative project that has produced the DVD are Fife, Highland, Renfrewshire and West Lothian Councils. The DVD makes use of a range of ICT-based approaches to both CPD and classroom activities. The original concept of the DVD was to use ICT to widen opportunities for CPD particularly for those in remote and rural areas but, in fact, the approach is probably useful for all teachers.

Classroom teachers, in the four local authorities involved in the TEST consortium, have developed all the activities on the DVD. These CPD activities illustrate good practice in science lessons by exemplifying a range of techniques that can be used to enhance learning and teaching. Such techniques include sharing learning intentions and success criteria; using attention grabbers; using good questioning; carrying out investigations; and engaging with ICT. The activities focus on the key scientific ideas that underpin the curriculum P6 - S2. The DVD aims to support *A Curriculum for Excellence* (ACfE) through addressing staff development needs in science. Dissemination to Local Authorities (one DVD for each school) will take place in December 2006.

The remainder of this article provides a brief summary of the other outcomes of the Improving Science Education 5-14



through CPD initiative. This stemmed from *A Science Strategy for Scotland*, and was based on the HMIE Report, *Improving Science Education 5–14*. A major aim of the initiative was to build capacity for high quality CPD for school science educators across Scotland and SSERC was awarded a grant from SEED to manage the project over the period 2002–2006. Previous updates on the progress of the ISE 5-14 through CPD project can be seen on the ISE 5-14 website at http://www.ise5-14.org.uk/Prim3/Local_links.htm

The implementation of the project was to be carried out by a number of consortia. Conditions of funding required that each of the consortia included cross-authority collaboration and cross-sectoral working between primary and secondary schools. A number of the consortia also included membership by Higher education institutions and/or science centres. Within the duration of ISE 5-14 CPD initiative, five consortia were established and their projects implemented across Scotland.

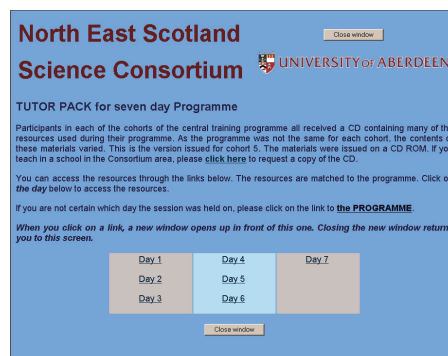
Whilst each of the consortia adopted their own, individual approaches to increasing capacity for CPD, all focussed on learning and teaching methodologies rather than merely on specific areas of content. A short description of each of the projects follows and a summary of the partners involved in each consortium is detailed in Table 1.

Gallus: The partnership trained a small number of national or Category A Trainers (CATS). These CATS went on to develop materials and coach 45 local authority trainers (LATS) in their use in a five day course. These LATS were recruited from each of the LA partners. The final two days of LAT coaching were tailored to fulfil the needs of individual authorities, the first three days being common for all. The LATS, in turn, rolled out the training to teachers across their own authorities. The main themes of the training were: The Thinking Classroom;

Formative Assessment and The Investigative Approach/Science with Attitude. You can access the Gallus material on the SSERC website at http://www.ise5-14.org.uk/Prim3/New_Guidelines/Investigations/Menu.htm. Clearly, these local trainers remain as a valuable resource for the authorities to support implementation of *A Curriculum for Excellence*.



NESSC: The main aim of NESSC was to develop existing structures to build capacity for sustainable programmes of CPD across the LA partners. The project used two models for training delivery to classroom teachers and training support. Each of the models was used in two authorities. The models differed in the identification of trainers. One set of trainers comprised locally-based science co-ordinators and the other, a small team of seconded teachers who had been trained through the project. A seven-day programme formed the core



Consortium	Partners
GALLUS – Glasgow and Lanarkshire Learning for Understanding in Science	Glasgow City, North and South Lanarkshire Councils; Glasgow Science Centre; Glasgow University
NESSC – North East Scotland Science Consortium	Aberdeenshire, City of Aberdeen, East Dunbartonshire and Moray Councils; SATROSPHERE; University of Aberdeen
SEES – South East Earth and Space Consortium	East, Mid- and West Lothian, Edinburgh and Scottish Borders Councils; Our Dynamic Earth; Royal Observatory (Edinburgh)
TEST – Technology Enhanced Science Teaching	Fife, Highland, Renfrewshire and West Lothian Councils
TSEC – Tayside Science Education Consortium	Angus, City of Dundee, Perth and Kinross Councils; Angus Digital Media Centre; Sensation Science Centre in Dundee

Table 1 - Consortia and their partners

training and was common for all trainers. The core training programme was provided to 129 teachers who, in turn, trained a further 659 teachers through training programmes. About 1,470 teachers were also supported in the classroom. Evaluation of the NESSC project identified that both models were found to be very useful in increasing teacher confidence, with Primary teachers placing particularly high value on classroom support. Sustainability, however, remains an issue, particularly in those authorities where teachers had been seconded to become trainers. The likelihood of recall from secondment was fairly high and hence training capacity was not maintained. You can access the materials at <http://www.abdn.ac.uk/education/projects/nessc/courses.htm> (A full evaluation of the project, *North East Scotland Science Consortium – Project Evaluation*, was carried out by Chris Fraser and Jim Murdoch of the University of Aberdeen)

SEES: SEES focussed on developing training materials to support learning and teaching in the Earth and Space strand of 5–14 science. One primary and two secondary teachers were seconded to make up the SEES CPD project team. Prior to developing SEES CPD materials and courses, the project team carried out extensive research to identify areas within the Earth and Space strand where teachers were in need of greatest support. They also identified those features which make for good quality CPD. The materials and courses produced were refined after piloting and were used to train local authority trainers, firstly within the consortium and latterly to LAs across Scotland. Just over 400 teachers and trainers have undergone SEES training.

TEST: see start of this article.

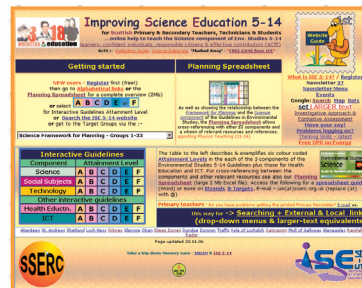
TSEC: TSEC produced a DVD and CD-ROM package that was sent to all schools in Scotland, for use by teachers, schools and trainers. One of the aims in producing the package was to provide the 'how' as well as the 'what' of good teaching practice. To accomplish this, video footage of teachers with their pupils putting into practice a range of strategies that support learning and teaching is a key feature of the DVD. The CD-ROM contains related teaching materials and further information for teachers and trainers. Whilst the package covers 'Living things and the processes of life', the methodologies exemplified could be adapted for any subject (and not just within the sciences). Further information may be found on the ISE 5-14 website at http://www.ise5-14.org.uk/members/TSEC_DVD/News_and_Background.htm

Support for Science Education through CPD

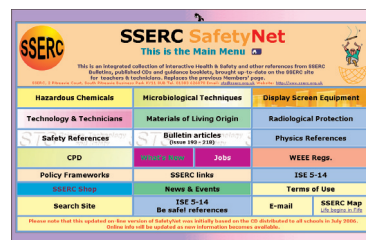
ASE Scotland/Good Practice conference: 9th & 10th March 2007, Crieff Hydro: Programmes and application forms have been sent to all schools.

Summer schools: Planning and preparation for the Biotechnology and Biosciences, Chemistry and Physics Summer Schools in 2007 are already underway, as well as for the residential event for all PGDE science students. Further information will be distributed at the beginning of the spring term.

Websites: The SSERC, ISE 5-14 and SAPS websites continue to evolve and partners in the project are always available to respond to enquiries and questions that you send us either through the websites or by telephone.



www.ise5-14.org.uk/prim3/head2.htm



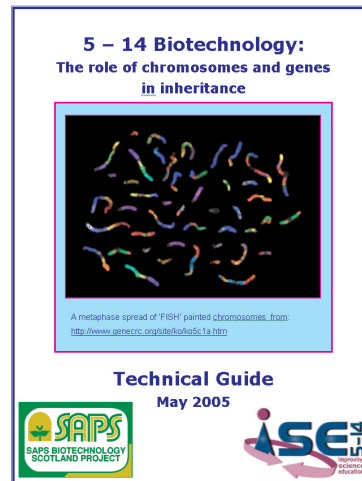
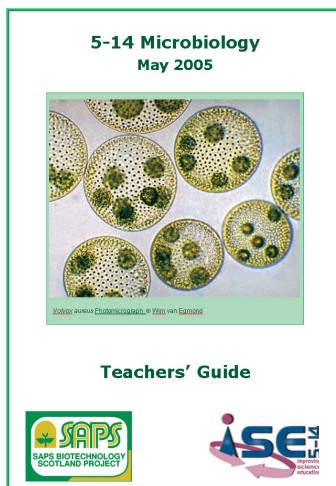
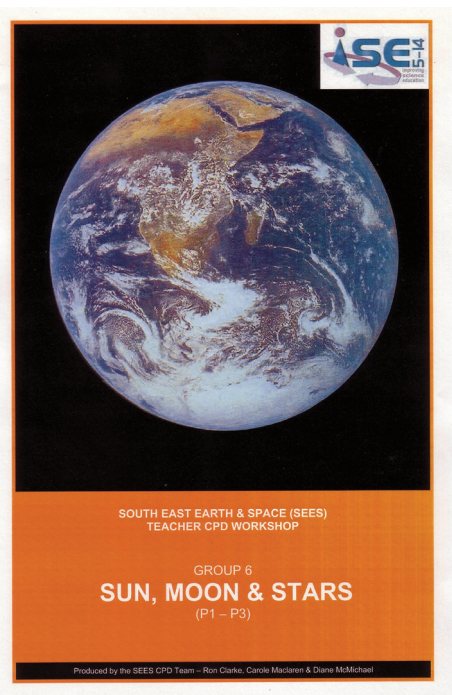
www.sserc.org.uk/members/SafetyNet/Safety_MENU.HTM



www.saps.plantsci.cam.ac.uk



SSERC 'n' SAPS: SSERC and SAPS have produced a range of practical work and associated active learning activities (see below) to support the microbiology, inheritance and biotechnology Attainment Targets at levels E and F of Environmental Studies. Contact Kath Crawford for further information :- kath.crawford@sserc.org.uk



Radiant heaters

Introduction

The comparison of the rates of heating of a black body versus a silvered body can be done with proprietary apparatus, either the Low Voltage Radiant Heater made by Philip Harris (B6H25547, £41. Figure 1), or the Radiant Heat Source by Nicholl Education, which operates at mains voltage and is well insulated. Both heaters get red hot and are suitably guarded against accidental contact. They are both the right products for this experiment and can be recommended.

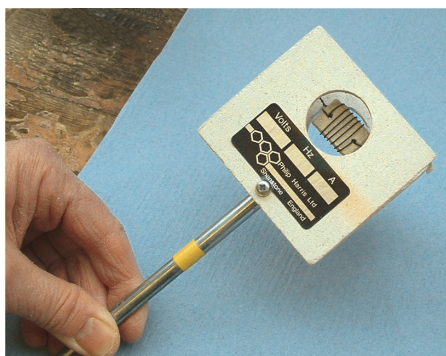


Figure 1 - Harris Radiant Heat Source
But why not get pupils making their own heating elements? That would be more fun, and more instructive. If provided with the apparatus, all that the pupils have to do is watch the temperature creep up. How boring! But if they have learnt how a heater is made, and had the satisfaction of making one, getting it to work and testing it out, then the consequent experiment becomes much more pleasing.

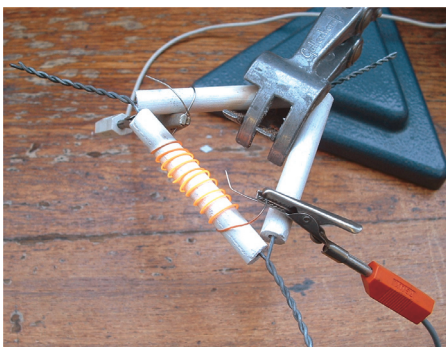


Figure 2 - Nichrome wire winding on pipeclay triangle.

A heater element can be made by wrapping about 25-30 cm of 24 SWG nichrome wire around one rod of a pipeclay triangle. The turns should be tight and neat, but not touching, nor overlapping. There should be about 6 cm extra nichrome wire at both ends of the heating coil to secure by a single turn around an adjacent pipeclay rod (Figure 2) for better mechanical holding. The overall length of nichrome wire needed is about 40 cm, but perhaps no more than

30 cm conducts the current. Contact with flexible copper leads can be made with croc clips. The power supply is 12 V ac, delivering about 7-8 A. The nominal radiant power is 100 W.

The pipeclay orientation can be horizontal (Fig. 2) or vertical (Fig. 3). The latter orientation would let two calorimeters to be irradiated simultaneously.

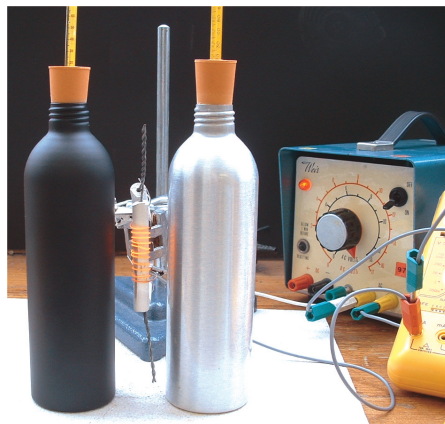


Figure 3 - DIY Radiant Heat Source mounted vertically between black and silver cans

Experimental notes

Two separate vessels can be heated simultaneously for comparison. Suitable ones are thin-walled aluminium cans with recessed bases. One ready-made set are the Radiation Cans, TD-8570A, from PASCO (Fig. 2) (the set of three are coated black, silver and white, the white is not shown). These have a capacity of 320 ml. Other suitable vessels are 100 ml, used, drinks' cans, such as ones that had held Schweppes' tonic water, painting one matt black and covering the other with aluminium foil.

The setup is shown in Fig. 3. The heating element must be off until the vessels are in place. Each is filled with water, which should be a few degrees cooler than room temperature, the weights being evened by weighing. The uniform separation of 10 mm was achieved by using a 4 mm plug as a spacer (the width of the plastic holder is 10 mm). The element is switched on for a period of 5 minutes with a 100 ml vessel, or 10 minutes for one with a larger capacity. The risk of harm from accidentally touching the hot element is quite low because, with the cans in place, they act as guards. The experiment is reasonably safe.

	100 ml drinks' cans	PASCO Radiation Cans
Capacity (ml)	100 (nominal)	320
Mass of water (g)	160	320
Period heater was on (s)	300	600
Temperature rise (°C)		
Silvered can	0	4
Blackened can	5.5	8

Table 1 - Temperature rises of water in irradiated cans, both cans, black and silvered, irradiated simultaneously.

Results with both sets of cans (Table 1) show the effectiveness of the method.

The method can be criticized in that the silvered flask reflects much of the radiation that is incident on it towards the black flask. On the other hand the black flask emits more black-body radiation than the silvered one and some of its flux will be absorbed by the silvered flask. Therefore the experimental conditions aren't ideal. Heating the cans one by one, while overcoming these errors, introduces another, the continual fluctuation of mains voltage. Because power varies as voltage squared, the radiant output should not be presumed to be constant and can vary by quite a lot. Simultaneous heating overcomes this problem. Another problem is that the water in the canisters cannot be agitated to mix the contents during the heating process for fear of displacing the cans. Therefore the telling temperature is the final one, after the heater has been switched off and the can picked up and shaken.

While the main place for this heat experiment is in Second Year Science, it could also form the subject for an Advanced Higher Physics Investigation. Consider the facts. (The following data is from the black PASCO can and not with the results in Table 1.) By Euclidean geometry, about 15% of the radiant emissions from the heating element falls on the can's surface. In one run with a single, black can, the electrical energy supplied in 10 minutes was $56.0 \text{ kJ} \pm 0.3 \text{ kJ}$. Therefore the energy radiated towards the can was $8.4 \pm 0.9 \text{ kJ}$. From the temperature rise, the energy taken in was $8.2 \pm 0.7 \text{ kJ}$. The values agree. Virtually all of the radiated energy was absorbed. This was a quick look at the energy changes. There would seem to be scope for much more research for anyone so-minded.

Risk assessment - Because of the risk of fire and burns, the heater must be held in a clamp stand before being energised. This should be set up over a heat-resisting mat, away from the edge of the workbench. There would seem to be no simple way of shielding the element from accidental contact, particularly so when it is being tested during the construction stage. Pupils therefore must be warned not to touch the element, and of the

risk of fire. They must be supervised throughout the practical. During the experimental phase, canisters of water on either side act as barriers against accidental contact (Fig. 3).

Scottish Technicians' Consultative Conference 2006

"Technical Support in schools must be strengthened so that pupils can have the experience and stimulation of hands-on practical work" and "Such staff members should be seen as an integral part of the science provision, having access to appropriate CPD and career enhancement opportunities".

The above is an extract from the Scottish Science Advisory Committee (SSAC) report – *Why Science Education Matters: Supporting and Improving Science Education in Scottish Schools* [1] – and the main reason that a project, funded by the Scottish Executive, was established in early 2005 to look at CPD and other related activities for technician services throughout Scotland.

1st Consultative Conference for Technicians (2005)

It is fair to say that the findings of any such project would be incomplete without first seeking the views and opinions of those at the chalk-face (or should that be whiteboard-face these days?).

It was for this reason that all Scottish local authorities were asked to nominate technician delegates to attend a consultative conference which was held in Crieff Hydro Hotel in late 2005. This was the first time that technicians from all over Scotland had been brought together in this way. The conference was judged to be a resounding success and it was agreed that a second conference should take place in 2006. A report from the first conference is available on the SSERC website [2]

2nd Consultative Conference

In 2006, all Scottish local authorities were invited to nominate delegates to attend a second consultative conference which was held in Crieff Hydro Hotel from 1 to 3 November 2006. Seventy-one delegates (representing 28 local authorities) attended.

Feedback from delegates indicates that the second conference was every bit as successful as the first. A full conference report is in preparation and will be issued to interested parties. An electronic version will also be made available on the SSERC website. The following is a brief outline of the event:

Project Update

Phil Muggins, Project Officer provided a project update covering the results of the National Survey [3] conducted by the project team between June and December 2005. She also updated delegates on CPD training programmes being



Figure 1 - Delegates had an opportunity to view training DVDs

developed and how these were progressing through the SQA for eventual credit rating and levelling. A total of 196 training days had been provided, so far, for technical support staff from throughout Scotland.

SafetyNet

Ian Birrell, SSERC's Network Designer, demonstrated the merits of *SafetyNet* CD and online as a reference tool for teachers and technicians. It was apparent that initiatives such as Safety Net would only be of use if technicians had access to a computer. A show of hands indicated that all delegates had either a dedicated computer or had access to one within their department. In evaluation forms 95% of delegates rated Safety Net as either 'Excellent' or 'Very Good'. Five percent thought it was 'Good'.

Training DVDs

Delegates were given the opportunity to view (Figure 1) and comment on two DVDs (*Safe Use of Fixed Workshop Machinery* and *Safety in Microbiology for Schools*) developed to supplement CPD training material for technicians. The *Safe Use of Fixed Workshop Machinery* DVD, which still required some minor editing, was rated as 'Excellent' or 'Very Good' by 91% of the delegates. The *Safety in Microbiology* DVD, which was very much a 'work in progress', was rated as 'Excellent' or 'Very Good' by 52% of delegates. Forty one percent thought it 'Good'. However, there was general consensus that the concept of using DVDs as supplementary training material was an excellent idea.

Guest Speaker

Jim Killen, retired Chief Technician for Renfrewshire, sent delegates off to lunch with a smile on their faces following some amusing anecdotes from his experiences in the technician service. In order to protect the innocent, no names were used.

Discussion Groups

Following feedback from last year, and being of primary importance to the success of the conference, it was decided that more time should be allocated this year for the group discussion session.

Delegates were divided into eight groups of nine with a Scottish Technicians' Advisory Group (STAG) representative appointed to each group to facilitate discussion.

Each group was given five key areas to discuss, asked to appoint someone to take notes and a spokesperson to present the group's findings at the feedback session the following day.

The key areas of discussion were:

1. Structures for Technical Support Staff
 - Schools
 - Central Services
2. Training
 - Induction Programme
 - Funding
 - Further Training
3. Appointment of Trainees
4. Staff Retention
5. Raising Technician Profile.

The feedback from the group discussions will be used to form the basis of recommendations in the final report to SEED.

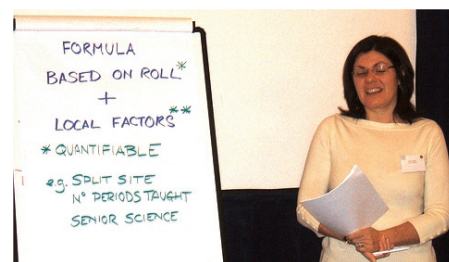


Figure 2 - Each group was given 5 key areas to discuss, asked to appoint a note taker and a spokesperson to present the group's findings at the feedback session.

Closing Address

Delegates were indeed privileged to have Bristow Muldoon, MSP for Livingston to give the closing address. Bristow has a BSc in Chemistry from Strathclyde University and is therefore no stranger to laboratories or the work of technicians.



Figure 1 - Bristow Muldoon MSP for Livingston

In his address to the conference he stressed that if students were to be inspired to choose science and technology as a career option then the teaching of these subjects must be relevant, exciting and fun. This could only be achieved if teachers were given proper technical support by well-trained and motivated technicians. It was gratifying that someone of Bristow's stature should take time away from a busy schedule to address the delegates.

The future?

Brian Richmond, Project Manager, closed the conference by outlining where the project would go from here.

The project team would continue to develop training programmes; it would arrange to have them trialled and prepared for submission to the SQA for credit rating and levelling within the Scottish Credit and Qualifications Framework.

At the end of the project it was hoped that there would be a range of CPD opportunities for technicians that carried national recognition, were transferable and more meaningful than in the past.

Through the final report the Scottish Executive would receive recommendations which it was hoped, would make the technician service a more attractive career choice that would help retain existing staff, attract good quality recruits into the service and address the problem of the age profile of existing staff.

Those who contributed to the success of the conference were thanked for their efforts and following a welcome lunch, the delegates left the sanctuary of the hotel to begin their journeys through the pleasant autumn sunshine back from whence they came.

References

- [1] http://www.scottishscience.org.uk/main_files/pdf/Publications/Science_Report.pdf
- [2] [http://www.sserc.org.uk/members/SafetyNet/Technology/Tech%20Conf%2005%20%20Report\[1\].doc](http://www.sserc.org.uk/members/SafetyNet/Technology/Tech%20Conf%2005%20%20Report[1].doc)
- [3] http://www.sserc.org.uk/members/SafetyNet/Technology/Main_Menu.htm

Audacity - Further experiments

Following on from the Audacity article in Bulletin 218 here are some more :-

Bell or buzzer in the bell jar - Tape the microphone to the side of the bell jar and adjust microphone input level to full scale when the bell/buzzer is going with air in the bell jar. Gradually evacuate the jar and watch the amplitude of the trace. You will of course need to isolate the sound of the vacuum pump. Alter-

natively set an old-fashioned alarm clock (with bells) to go off once the bell-jar is evacuated. No one can hear you scream in space!

Howling Wolf - Wolf sound analysed with Analyze - Plot Spectrum then Tone generated to match up with natural sound. Use the web to find whale songs and compare the frequencies with that of the wolf.

Half full or half empty - 100 cm³ glass beaker (empty) 'dinged' with a pen and allowed to ring. Frequency analysed and pure tone generated. Beaker half filled with water and process repeated. Why not try a calibration curve of frequency vs. volume?

There are more ideas for experiments with Audacity to be found at :-

http://www.sserc.org.uk/members/SafetyNet/bulls/218/Audacity_concluding_remarks.htm

Wiring plugs – banned or not?

Recently we have been asked by a number of schools whether it is legal for pupils in schools to wire plugs or other mains devices in the context of learning about mains electricity. We believe that there is no legal reason why you should not continue to do this very worthwhile training. The Electrical Safety Council (more below) agrees and, moreover, wholeheartedly supports the activity.

We trust that that scotches this myth, which, we presume, has arisen from commentary in the press following the introduction of the Building (Scotland) Regulations 2004, and similar regulations in England. Briefly, a building warrant is now required for many re-wiring jobs, but the need for a warrant depends on the type of work and type of building. The

law therefore seeks to ensure that house re-wiring is done competently. It does not, so far as we are aware, regulate the wiring of portable appliances. In any case what schools are engaged in is education and training, not house or school re-wiring. Controls on the re-wiring of buildings have no bearing on children being taught to wire a plug.

Dead working

Just a reminder that during the plug-wiring practical the mains electricity supply to the lab must be dead throughout the exercise. Information on electrical isolation can be found in Bulletin 209 [1]. Control measures and a justification for the activity were published earlier in Bulletin 181 [2].

Electrical Safety Council

This new, re-named, public body, established in April 2006, seeks "to be the most influential and respected UK driving force for consumers in the field of electrical safety". Its formation is the result of the renaming of the highly respected National Inspection Council for Electrical Installation Contracting (NICEIC). The need for renaming is understandable. NICEIC will continue to work with the electrical contracting trade, whereas the Electrical Safety Council will be a provider of advice to the general public. To see their tips on checking a plug, go to their website [3]

[1] www.sserc.org.uk/members/SafetyNet/bulls/209/safety1.htm

[2] www.sserc.org.uk/members/SafetyNet/bulls/181/2-6.htm#Pupils%20wiring%20plugs

[3] www.electricalsafetycouncil.org.uk/tips.html