SSERC
SCOTTISH SCHOOLS EQUIPMENT RESEARCH CENTRE

Science & Technology Equipment News

Number 3 Autumn 1994

For teachers in Primary schools and of S1/S2 Science & Technology courses

Only recently did we begin to get responses to our plea in Issue 1 for comments on the usefulness of a Science & Technology Equipment News for 5-14. As a result of such comments we may well change the format and content quite radically for the next issue. We have made the common mistake however, of committing ourselves in the the last issue to certain kinds of coverage in this. It seems that for now, we will have to stick to Plan A and bring to some sort of conclusion our earlier scribblings on choosing and using optical instruments.

Please keep up the flow (trickle?) of comment and criticism. We need to get a better idea of the kinds of information and advice useful to practitioners. To that end some of the SSERC staff have been helping to develop a Primary Science and Technology Kit for teachers in Borders Region. Sometime this term we also hope to be assisting in the classroom with work on teaching investigative skills in science at the Primary level. With the assistance of the Engineering Council we are exploring some new links outwith Scotland. These may lead to a number of co-operative arrangements. The first and most practical of these is that already we have a new source of additional components useful for technology projects (see back page).

More on magnifiers

In the last issue we promised a table with buying advice on specific models of magnifiers etc. With that in mind we have been evaluating a range of such devices from different suppliers. We devised a set of fairly objective tests to let us judge their optical quality. We are using sets of standard test objects to check magnification. Some of these will also reveal distortion or may be used to look for coloured fringes which suggest other optical defects.

Two things have stopped us finishing off that work. The first is that some suppliers have yet to send us samples. The second is that we also put our sample collection into a Primary school and then asked the children which types and models they preferred. At this point some cherished ideas went oot the windy!

They want it all

Our group of P6 pupils tried out a range of devices to look at insects, materials including paper and the way in which colour photographs are printed. Some of their opinions as to the relative merits of different magnifiers or *Nature Viewers* initially surprised us. On reflection however they are understandable and give an insight into different needs of children at various stages. They also teach us technophiles humility and not to make so many assumptions.

For example, some of the children had used each of two apparently similar hand held magnifiers of the "Sherlock Holmes" type - round lenses on a handle. From our tests we knew that one was of higher power and of markedly better optical quality than the other, although the poorer lens was of larger diameter.

With hardly any exception the children preferred the larger, but - in our opinion - much poorer, lens. When asked to explain this preference nearly all of the pupils said they liked lenses which magnified in such a way that they could still see the whole specimen. They were uncomfortable with the smaller field of view of the optically superior lens. This seemed to be because they were having to look at a magnified image which was a part only of the original object. Figure 1 should illustrate the principle. The effect is worsened when the lens itself is of small diameter.

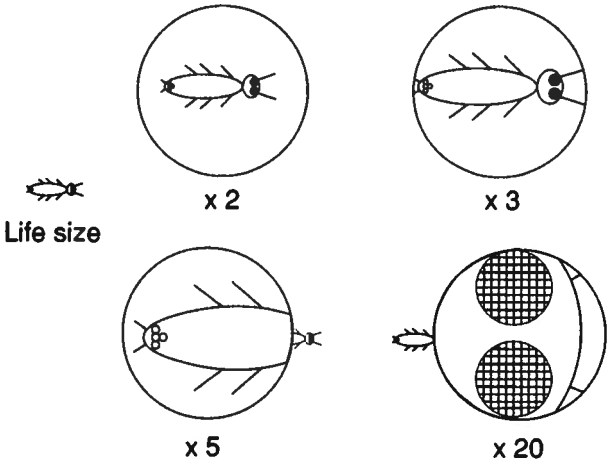


Fig. 1 Diminishing fields of view with increasing magnification

This bears out one of our earlier warnings on the need for careful use of conventional microscopes in Primary and lower Secondary (see Issue No.2). (cont./over)

What came as a surprise was the extent to which a wish to continue seeing the whole specimen may mean that pupils ignore optical inferiorities which are obvious even to an experienced adult.

Other surprises included the ease with which pupils could intuitively select the right type of device for a particular application and reject it when its use was inappropriate. One such example was our sample of an inexpensive "pocket" microscope with a built in battery illuminator. This was happily used to examine paper or the way in which printed colour photographs are made up of separate dots. It would not be chosen to look at "minibeasts". The children realised that its relatively high magnification and small field of view combined with its fixed working distance (object plane to front lens) made it awkward for such usage.

Interim conclusion

We shall continue to gather in samples for testing. But before we can publish any firm advice on best buys we shall also have to learn more from the pupils themselves on how - literally - they see things. We are still happy to give buying advice on the basis of our work to date. For now this is probably best done over the 'phone or in response to written enquiries. Two named staff contacts are given at the bottom of the back page of this issue.

Binoculars and telescopes

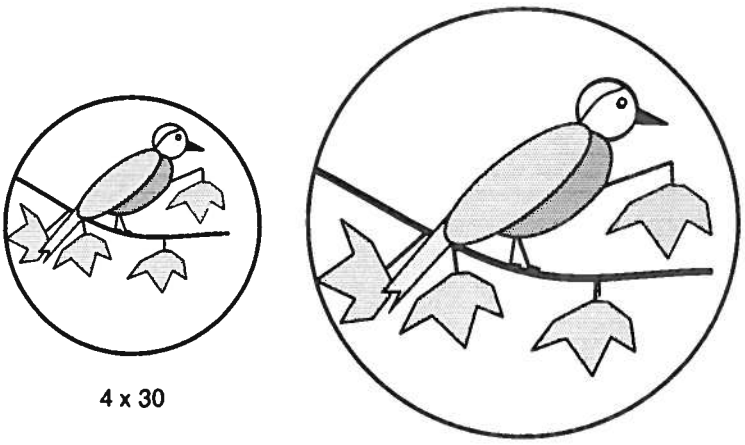
Many of the principles outlined in the previous newsletter for magnifiers and microscopes may be applied also to binoculars and telescopes. The first of these is that magnification is not the be all and end all. Also, just as for magnifiers, the greater the magnification the smaller is the overall field of view (see Fig.2). And, the less is the distance over which the object stays in focus when the instrument is adjusted or moved (see Figs. 2 and 3).

Figure 2 shows several combinations of figures commonly quoted in connection with binoculars eg *7, 8* or *10 x 30*. What do these numbers mean?

The first figure is the magnification and the second the diameter in millimetres of the front lens or *objective*. So, a pair of *7 x 30* binoculars magnify the object seven times and gather available light into an *aperture* thirty millimetres across. Note the parallel with figure 1. If the front lens diameter stays constant then the higher the magnification the smaller the field of view. Although ten by thirty binoculars will produce a bigger image of a bird, less of the bird itself may be seen. Also, the harder it will then be to find the bird in the first place or to track it in flight.

Note also what happens to the leaf in the background. As the magnification (often termed the *power*) is increased the less will be the depth of focus.

Suppose that as well as increasing the power we also increase the diameter of the front, objective lens. We're back to our magnifier evaluation results again. Figure 3 should make the point.



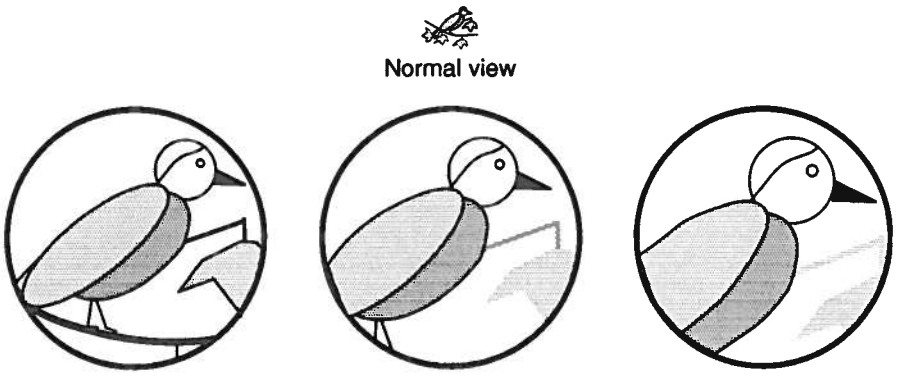
4 x 30

7 x 50

Fig. 3

An enlarged image of the whole bird can thus be obtained with a higher power if we also increase the diameter of the front lens (aperture). The problem of a smaller depth of focus cannot be got round in this way.

There is however something else to be gained by increasing the aperture and that is that more of the available light will be gathered into the instrument.



Normal view

7 x 30

8 x 30

10 x 30

Fig. 2

This is handy for general fieldwork in poor daylight and is even more useful when examining a night sky[1]. Light gathering power is also aided if lenses have special anti-reflective coatings. Most modern binoculars have such coated lenses.

A good compromise for general use is a pair of seven by fifties *(7 x 50)* or even eight by thirties for younger children.

1 In practice it is the ratio of the objective and eyepiece (ocular) diameters which determine whether or not the light beam will fill a wide open iris in the pupil of the eye.

Telescopes

All of the points made so far as to a necessary compromise between the magnification, field of view and depth of focus apply to terrestrial telescopes (also known as *monoculars*) - but in Spades!

Telescopes have to be held steady at one eye only and usually are much longer in the body tube than are binoculars or field glasses. They are thus hard to use even when relatively low powered. It can be very difficult to find and hold an object in their field of view. They are best supported in some way and we would recommend that, if used at all, they should be on a stand. This can be a simple, single rod (a monopod) or, better still, a tripod.

For these and other reasons we generally prefer the use of binoculars both for fieldwork and for simple astronomical observations.

Advice on buying

There are a number of detailed practical points to watch for when buying these types of instruments. But, as usual in this short publication, we are running out of space. Should you be considering such a purchase, then do contact the relevant SSERC staff (see back page) for further advice and information. Then we can provide more detail on what to look out for when buying, either new or secondhand.

Usage - where and how?

Some of the comments we had on Issue 1 welcomed the suggestion that we link advice on equipment to curricular contexts and teaching approaches. So for our next trick, which is also impossible!

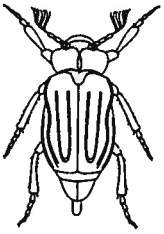
There seem to us two broad ways in which to bring more science and technology into the Primary part of the 5-14 continuum. The first is to introduce aspects of science and technology in what could be termed a stand-alone fashion. For those who use this strategy there appear to be two basic sets of tactics. One is to concentrate on investigations and problem solving and hope that skills and techniques transplant into other curricular areas. The other is to see that some work starts from, and is centred firmly on, a scientific or technological theme.

Another strategy is a more holistic approach where a theme may be chosen from one of a wide variety of curricular contexts. But here the aim is to have as many opportunities as possible to broaden out the work into lots of other curricular areas.

Each strategy has its own strengths and weaknesses. It is not our place to express any preference. It would be unfortunate however if these approaches were to be seen as mutually incompatible.

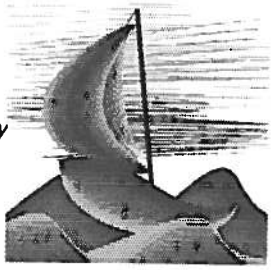
These ideas may be illustrated with suggested uses for the sorts of optical instruments reviewed in this and in the previous issue of the "News".

Examples



Much of this optical equipment can be used in general environmental work either in the school grounds or further afield. The science skills covered include the obvious observing, recording and "sorting"[1]. A similar but purely science based activity might centre on a theme such as "Minibeasts" and have much the same outcomes.

Magnifiers and microscopes are useful also in a study of materials - natural, man-made or both. Structure may thereby be related to use or function[2]. This whole area would lend itself well to what we have termed a "stand-alone" approach. Such deliberate study of everyday materials may also cover much technological process and content.

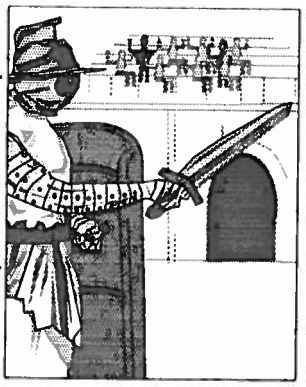


On the other hand it is equally easy to see how a topic with an exciting central theme such as "Ship-wrecked" or "Pirates" could cover very much the same ground.

Questions to prompt scientific investigation and techno-logical activity are not difficult to formulate in such a context. What are the fibrous natural materials out of which we could best make . . .?[2]

Such a topic also provides opportunities to bring in a manageable number of other aspects. For example, how do we tell the time of day and year on our island? If we try to escape how would we know which way to go? How can we tell which way North lies? Could a study of the sun and stars help us out? Here's another use for those binoculars (and the odd magnet or two)[3,4].

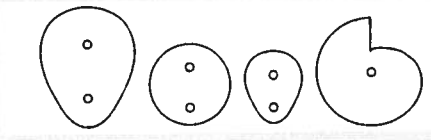
In turn this can bring in or reach out into studies on "People in the Past" or "People and Place". Almost any theme which raises chronological (Romans) or navigational problems (Vikings) offers such opportunities. Work on the scientific aspects of time may naturally lead into the development of technologies for timekeeping. This in turn poses questions and problems on mechanisms, gears, and pulleys[4].



If there are snags with such approaches they certainly don't lie in any shortage of chances to put scientific and techno-logical questions or to use appropriate processes and skills. The difficulties may well arise because of their richness of potential for teaching science and technology. This may make it hard to manage the breadth and depth of treatment at each level. Despite the difficulties a balanced usage of topic work may still offer exciting, and - above all - practical, science and technology teaching at the Primary level. Watch this space!

1. Understanding Living Things - Variety and characteristic features
2. Understanding Earth & Space - Earth in space : Materials
3. Understanding Earth & Space - Earth in space
4. Understanding Energy & Forces - Forces and their effects

Components & Materials List

593	Miniature motor, 1.5V to 3V, 2mm dia. shaft	30p
614	Miniature motor, 3V to 6V, 2mm dia. shaft.	45p
	Both of the above motors can be used for project work but they run at fairly high speeds, some form of gearing will be required. See item 625	
621	Miniature motor, 1.5V to 3V, 1.5mm shaft. The open body of this motor makes it ideal for showing how such a motor is constructed.	25p
625	Worm and gear, gives a 38 to 1 speed reduction.	35p
629	Dual tone buzzer with flashing light supplied with PP3 battery clip. Ideal for model burglar alarms, warning barriers, police car etc..	55p
710	Sonic switch. Clap your hands, the motor starts, clap again the motor reverses, on the third clap the motor stops. Needs 4 AA cells, not included.	45p
645	Ceramic magnets, reasonably strong, various shapes.	7p
688	Crocodile clips, red, miniature, insulated.	5p
759	as above but black.	5p
789	MES (miniature Edison screw) lamps (bulbs) 3.5V.	9p
691	MES battenholders for above.	20p
508	LED (light emitting diode) 3 mm, red.	50p/10
761	LED 3 mm, yellow.	60p/10
762	LED 3 mm green	60p/10
790	3V buzzer.	55p
788	Crocodile leads, assorted colours, insulated croc. clips at ends, 36cm long.	£1.35
791	Propeller, 3 blade to fit 2mm shaft. Blade 55 mm long.	45p
792	Propeller kit with hub and blades for ten 3 or 2 bladed propellers.	£3.40
793	Cotton reels (for making buggies, rubber powered tanks etc.) pack 10.	45p
794	As above but pack of 100.	£3.50
795	Tyre material for cotton reel wheels, per 1 metre length.	90p
796	Pack of 20 pulleys, 5 of each of 10, 20, 30 and 40 mm diameters.	£2.50
797	Pack of 100 pulleys, 10 mm diameter with 2 mm hole for motor shaft.	£10.00
798	Pack of 24 gears, 6 each of 12, 20, 30 or 40 teeth, dia. 15, 22, 32, 40 mm 12 tooth gear fits motor shaft and 40 tooth gear is push fit in cotton reel	£2.00
799	Pack of 24 cams, 6 of each of 4 shapes 	£1.00
800	Pack of 100 wheels, 39 mm diameter, assorted colours, 3 mm axle hole	£5.25

Payment with orders less than £5 and please add £1 for carriage then add VAT to the total.

SSERC, 24 Bernard Terrace, Edinburgh EH8 9NX Tel. 031 668 4421 Fax 031 667 9344.
For advice on magnifiers, binoculars etc. ask for Ian Buchanan or John Richardson