PUPIL RESEARCHER INITIATIVE

Project Rainbow

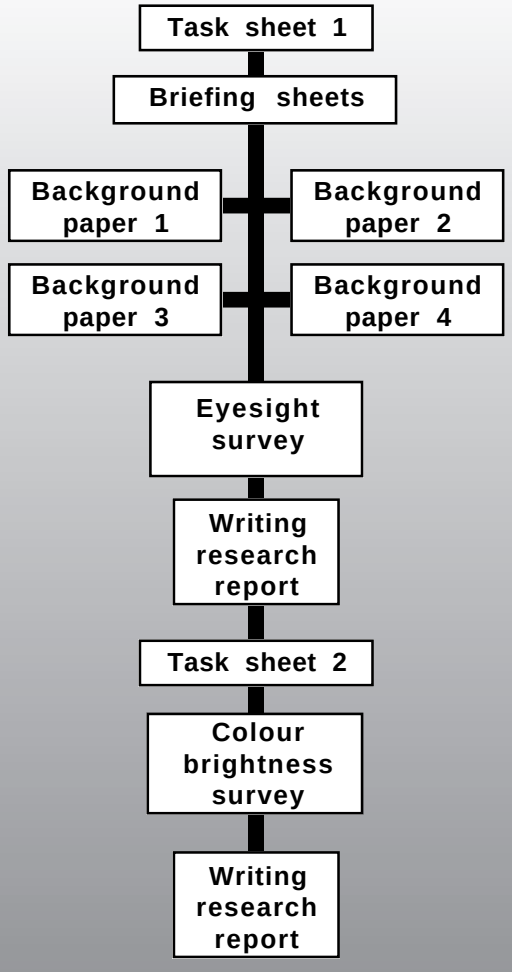
Pupil Research Brief

Teachers' Notes

Syllabus Coverage *Subject Knowledge and Understanding*

- ❑ short-sightedness means near objects can be seen clearly but not distant ones
- ❑ in short-sightedness either the lens cannot be made thin enough or the eyeball is too long
- ❑ in short-sightedness light from a distant object is focused in front of the retina
- ❑ long-sightedness means that distant objects can be seen clearly but not near ones
- ❑ in long-sightedness either the lens cannot be made thick enough or the eyeball is too short
- ❑ in long-sightedness light from a near object is not focused before it reaches the retina
- ❑ short and long-sightedness can be corrected using lenses

Route through the Brief



Introduction

This Brief takes its inspiration from *Project Rainbow*, a real research programme carried out by the University of Reading Research Group for Non-handicapping Environments, in collaboration with the Royal National Institute for the Blind (RNIB), the Guide Dogs for the Blind Association (GDBA) and ICI Paints. The main thrust of the Reading research is to provide architects and building managers with clear guidance on the best use of colour combinations and contrasts when designing the colour schemes for buildings.

The outcome of this research will be a set of colour data tables, which will allow designers to select aesthetically acceptable colour combinations which provide sufficient colour contrast to help visually handicapped people to navigate their way efficiently through buildings. The *Project Rainbow* team have been particularly interested in finding out the best colour combinations for people suffering from a range of eye defects, such as macular degeneration, glaucoma, cataract, retinitis pigmentosa and diabetic retinopathy.

The RNIB estimate that there are over 1 million blind or partially sighted adults in the UK. However, only 18% of these actually see nothing at all and even the majority of these are able to distinguish light and dark. This leaves 82% who do have some level of vision. Many can even read print if the text size is enlarged.

Pupil Research Brief

Teachers' Notes continued

In this Brief, pupils undertake a research survey in their own school or college. The aim of the survey is to find out the proportion of pupils who suffer from each of four common eye defects. These are:

- colour blindness
- astigmatism
- long-sightedness (hypermetropia, hyperopia)
- short-sightedness (myopia).

These defects have been chosen, because the causes of them can be understood by pupils studying examination courses and relatively simple diagnostic tests can be devised. In designing and carrying out their survey, pupils will produce data about their school or college population and then be able to carry out data analysis, including pattern identification, correlation and simple statistical analysis. Schools and colleges will have the opportunity to contribute results to a national database via the Internet. This information could be used by some pupils to carry out further data analysis and comparison. Full details of PRI Internet facilities will be found in the General Teachers' Notes of the PRB pack 2 available in the Spring term of 1997.

Experimental and investigative skills

- planning experimental procedures
- obtaining evidence
- analysing evidence and drawing conclusions
- evaluating evidence

Prior knowledge

Pupils should be familiar with the structure of the eye and the functions of the main parts used in focusing (cornea, lens, ciliary muscle, vitreous humour and suspensory ligaments). They should understand how a focused image is produced on the retina and the laws of refraction.

Running the Brief

Pupil grouping

Pupils could work in a number of groupings during this Brief. Suggestions are:

Initial briefing	-	whole class; teacher-led discussion
Analysis of briefing sheets	-	pairs
Analysis of background papers	-	class in four large groups, but pupils could work as sub-groups of two; sub-groups will need time to report back within the larger group before plenary session
Plenary session to report back	-	whole class; pupil presentations
Final design of questionnaire	-	whole class; teacher-led discussion
Using questionnaire	-	pairs
Analysing data	-	pairs
Communication	-	individual, if written reports to be assessed
Optional follow-up-investigation		small groups, pairs or threes.

Timing

The Brief should take between 3-4 hours of classroom time. Extra time may be needed to write up individual investigation reports if these are to be used for examination assessment purposes. The optional follow-up investigation may add two hours to the teaching time.

Activities

This Brief does not require the pupils to get into a role. They will be carrying out real research into their own school or college population.

The teacher should issue pupils with the **Study Guide**, the **task sheets** and the two **briefing sheets**. The Study Guide provides pupils with a summary of what they should produce as they work through the Brief and acts as a checklist for pupils to monitor their own progress. **Task Sheet 1** provides an overview of the main part of the Brief, placing particular emphasis on the research process. The teacher can introduce the Brief using this sheet as a focus for class discussion about what science and engineering researchers do. This sheet provides the detailed guidance about what the pupils need to do.

Briefing sheet 1 contains two simulated newspaper articles - one outlining the problems faced by visually impaired people caused by insensitive building design, and the other the problems that could occur because of the reduction of eye testing in secondary schools. **Briefing sheet 2** describes the real Project Rainbow, which was established to help overcome some of the design problems outlined in the newspaper article. Pupils will need to read the

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Briefing sheets and address the points raised on **Task sheet 1** (section 1). This could be carried out as a paired activity. Following the analysis of the Briefing sheets, the class should be divided into four large groups. Each group will have the responsibility for dealing with one of the four **background papers**, writing a brief account of the eye defect described in their paper, devising a diagnostic test for the defect and reporting back to the whole class about their work.

Each of the background papers describes one of the four eye defects, and leads the pupils towards designing the relevant diagnostic test. Pupils are directed, in Task sheet 1, to ask if any test charts or cards are available. Glasses should not be worn by the subject during any of the tests. The suggested tests are:

Paper 1 - *Colour blindness*. The simplest test is to use Ishihara cards. Full instructions for use are given in the notes which accompany the cards which are available from Philip Harris.

Paper 2 - *Myopia*. The most common test for myopia is the *Snellen Chart*, which is familiar to most people and found in many school or college medical rooms. They could be obtained from opticians, health centres or doctors' surgeries. The instructions for using the chart are included in the Myopia background paper.

Paper 3 - *Hypermetropia*. This involves using a test card designed to be read from 33cm. It contains text in a variety of sizes. Long-sighted people can only read large type at such a close distance. Type size ranges from 5 point to 48 point. Only those able to read 5 point type at 33cm could be said not to be hypermetropic. Opticians often use a card with a text taken from a book. Sections of the text are printed in different point sizes, with the smallest (5 point) usually placed at the top of the card.

Paper 4 - *Astigmatism*. This can be detected using a test card showing a series of thin lines radiating from a central point. Non-astigmatic people, with no other eye defects, will see all the lines in focus at once. Astigmatic people will see vertical or horizontal lines clearly, but as the lines radiate away through 90°, they will become blurred and wider. An astigmatism test card should be produced by the pupils themselves.

Each group should report back to the class outlining their work. They should describe the nature of the defect, including causes, and ways that it can be remedied, although colour blindness is not treatable. Each group should outline their diagnostic test, possibly with a demonstration to show the rest of the class how to carry it out.

Following the reporting-back session, the teacher should lead a class discussion about the details of the **survey questionnaire**. The aim of the survey is to measure the frequency of each of the four common defects. It is thought that the defects are more common than is widely appreciated, and that many young people suffer from hypermetropia and myopia without having been diagnosed as such by a doctor or optician. Survey data allowing the correlation of each of the eye defects to a number of other factors (such as gender, left/right handedness, occurrence of similar conditions in close family relatives, and age) will allow pupils to carry out some data handling activities based on 'live results'. Correlations between the occurrence of each of the defects could also be established. Pupils should consider how they will identify the population to be sampled. They could discuss whether the sample should be random (the first 30 pupils to visit the school office), or whether a sample has to be designed so that it reflects the gender, ethnic and age mix in the school. An alternative would be to carry out the survey within the class.

The outcome of the class discussion should be an agreed list of questionnaire items, the identification of the sample population, and an understanding of the importance of using a standardised method to collect the data. The teacher must then collate the questions and diagnostic tests into a single document, which can be copied and distributed to the class in the next lesson.

Task sheet 2 provides a second possible investigation. Pupils need to devise a method to give numerical values to colours. Part of the *Project Rainbow* research at the University of Reading is looking into this issue, with the aim of providing architects and designers with reliable colour charts that can be used to provide aesthetically pleasing colour schemes for buildings, so that an adequate visual contrast is provided. The Reading research is also looking at the performance of visually impaired individuals in navigating through specially painted environments, to back up their colour chart data recommendations. Quick-drying paint (supplied by ICI) is used to produce a series of colour schemes.

Pupils will produce their own **colour charts** showing which colour combinations provide sufficient contrasts. Further follow-up work is suggested, involving the pupils in surveying their school environment to establish whether it meets their own criteria of sufficient colour contrast. Simulations of eye conditions such as cataract (using safety goggles

with lenses made less transparent) could be set up to measure the performance of individuals in navigating their way along a corridor, finding light switches and notice boards, etc. There are possible links with Design and Technology if the pupils went as far as re-designing their school environment to provide better access for visually impaired people.

Investigation details

Pupils can carry out the survey in pairs, each pair being allocated a manageable number of individuals to survey. Pupils will need to be aware of the importance of using a standardised method, so that reliable results are obtained which can then be validly collated for the whole class. This is particularly important if the results are then fed into the database on the PRI Web site.

Following the survey and the collation of results, pupils can carry out a series of data-handling activities to establish correlations. This could involve setting up a computer data base. Pupils could then produce hypotheses which can be tested by interrogating the data. For instance, an hypothesis might be: individuals who are long-sighted are more likely to be astigmatic. However, it might be difficult for pupils to support each hypothesis with scientific knowledge. If they have studied genetics, they may link gender with colour blindness.

Pupils could write up their own **reports** based on the preliminary work on the background papers, the survey and the data analysis.

The second investigation requires pupils to devise an **objective test** to give numerical values to colours, based on their brightness. Light probes and datalogging equipment could be used to establish the data. Controlled tests will need to be carried out. For instance, if pupils illuminate their colours with a light bulb, they will have to ensure constant conditions (distance, angle, etc). They may decide to make a hood for the light probe to remove the effect of ambient light on the probe.

Using IT. Light sensors can be used to measure colour brightness. A database or spreadsheet could be used to collate the data collected from the eyesight survey.

Technical details

The Snellen Eyechart, the chart for testing long-sightedness and the Ishihara cards, if not available already in school, can usually be borrowed from the local Health Authority Health Promotion Unit. Ishihara cards can also be obtained from Philip Harris. Care must be taken that any photocopies made of the eye test charts reproduce exactly the same font sizes as on the originals.

Safety issues

PLEASE NOTE: It is also important that you prepare your own risk assessments for the practical work in this Brief in the usual way.

Sensitivity to feelings: survey work means asking questions about 'defects' of vision to which some people (especially children) can be very sensitive. Discussion of issues during preparation of questions is needed as well as some monitoring by teacher(s) during the survey.

Apparatus construction and use: the colour investigation may involve construction of light boxes, use of bright lights, lights of unusual wavelengths. Ultraviolet and Infrared can cause damage to eyes and/or skin. However, ultraviolet and infrared are not required for the purposes of this Brief. If any extension is planned into these areas then full risk assessments should be made.

Checks required for safety of construction, electrical safety and methods of use.

Assessment issues for *Experimental and Investigative Science* (National Curriculum for England and Wales, Northern Ireland Curriculum)

P	Planning	O	Obtaining evidence
A	Analysing evidence	E	Evaluating evidence

1 Eyesight survey

Devising the strategy for the eyesight survey of individuals could lead pupils to achieve across the whole mark range for **Skill Area P**. For **Skill Area O** pupils will need to carry out systematic and accurate observations, bearing in mind the need for reliability, to achieve the higher marks. There should be scope for statistical analyses of varying mark standards, from tables, through charts and graphs, leading to conclusions based on the evidence and correlations of factors. In this way, the full mark range for **Skill Area A** is possible. Achievement in **Skill Area E** could also cover the whole mark range and is likely to depend on the approach taken in the other skill areas.

2 Numerical values for colours

This is a relatively straightforward investigation to carry out once a method has been devised and standardised conditions have been established. It is likely to lead to low to middle marks for **Skill Areas P, O, A and E**. However, strategies which take into

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account a wide range of factors affecting ambient conditions, awareness of the drawbacks of comparing data taken from several light sensors (which are not likely to be standardised, with the same light level producing different readings with different sensors), statistical treatment of data, and awareness of issues related to variation in human perception of colour could result in achievement of higher marks in some or all skill areas.

Scottish syllabus coverage

Standard Grade Biology - *Body in Action*

Further pupil research opportunities

When people go to take a driving test they are asked to read a distant number plate. Drivers must be able to read a car number plate from a distance of 20.5m. A one-eyed person with 6/18 vision would pass the test! Even so, it is estimated that one third of drivers would fail the test. Pupils could carry out a survey of drivers to discover how many would pass. They could also suggest ways in which the eyesight component of the driving test could be improved.