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ENVIRONMENTAL SCIENCE
IN LINCOLNSHIRE
PRIMARY SCHOOLS

A CASE STUDY AND SURVEY

BY

M. E. CORNWELL

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ABSTRACT:

1) An historical overview traces the start of concern for the environment in the latter part of the 19th century through to recent international conferences to discuss the importance and implementation of environmental education at all levels. The case is then put for the importance of a structured environmental science scheme in primary education tailored to children's development.

2) A case study of a Lincolnshire primary school follows the planning, building and utilisation of a school environmental science area. It includes the development of an environmental science curriculum and the production of suitable interpretative materials and teaching aids. This is followed by an attempt at a summative evaluation of its effect.

3) The results of a questionnaire survey of Lincolnshire primary schools to determine the present situation with regard to environmental science practice, facilities, and provision are presented. These are compared with a similar survey carried out ten years previously. Minor differences are revealed but the overall pattern of results indicates that there has been little improvement in the intervening decade, and that a great deal of work still needs to be done if environmental science in primary schools is to be accorded its rightful position and importance in the curriculum.

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1985

"Bubbles gargled delicately, bluebottles
Wove a strong gauze of sound around the smell
There were dragonflies, spotted butterflies,
But best of all was the thick slobber
Of frogspawn that grew like clotted water
In the shade of the banks. Here, every spring
I would fill jampotfuls of the jellied
Specks to range on windowsills at home,
On shelves at school, and wait and watch until
The fattening dots burst into nimble-
Swimming tadpoles. Miss Walls would tell us how
The daddy frog was called a bullfrog
And how he croaked and how the mammy frog
Laid hundreds of little eggs and this was
Frogspawn. You could tell the weather by frogs too
For they were yellow in the sun and brown
In rain."

From 'Death of a Naturalist'
by Seamus Heaney.

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Contents

CHAPTER 1

Introduction:

a short history of

Environmental Education

'Education is a process, and environmental education is a style of education, not entirely new but becoming more important every year.'

(S.McB. Carson 1978)

It was the Industrial Revolution which spawned the modern concept of 'environment'. By the late nineteenth century many working people were living in very poor conditions and Britain became the first country in the world to experience an urban environmental problem. The addition of restrictive learning practices in Board and Public Schools made it apparent that Victorian society's outwardly confident air of authority disguised an inner social repression.

Into such a climate came a new search for an improved human environment by some of the more critical thinkers of the time. To the forefront was Patrick Geddes (1854-1933), a Scottish Professor of Botany. He followed the current sociological thinking of Frederick Le Play (1806-82), was dissatisfied with school learning methods, and horrified at Britain's uncontrolled urban growth. He dedicated himself to the improvement of both education and the environment. In Edinburgh in 1889 he opened what was to be a unique educational establishment; The Outlook Tower.

He was ahead of his time by expounding the theory that children would learn better and develop a creative attitude to their surroundings by constructive contact with the environment. He believed human life could only flourish if towns and cities were beautiful and stimulating places to live, and demonstrated his ideas through regional and civic survey work conducted from The Outlook Tower. It is now generally agreed (Martin & Wheeler 1975) that Geddes my be regarded as the 'founding father of environmental education.'

After his death, the idea of education as a means of environmental awareness was taken up by the Le Play society. Their main approach was published in 1930 in the book 'An Introduction to Regional Surveying' by

C.C. Fagg and G.E. Hutchings. It provided a basic methodology for field studies in the countryside and was an influential contribution to environmental studies development in schools.

The 1930's showed an increase in concern about urban encroachment into the countryside, voiced by the Council for the Preservation of Rural England (founded in 1926). They were the first group to pressurise for national educational activity to protect the countryside. Such concerns were recognised by the creation of the Council for the Promotion of Field Studies in 1943 (now known as the Field Studies Council). Their aim was to provide residential centres where school and college parties could undertake scientific fieldwork. These activities produced an increase in countryside-related educational work.

After the Second World War many plans for environmental improvement expressed themselves in the Town and Country Planning Act of 1947. The need for a high quality urban environment had at last been officially recognised. The term 'conservation' was coming into increasing usage and 'conservation of nature' was a genuine concern in the wake of increased urbanisation.

The Nature Conservancy Council was instituted in 1949 and soon emphasised the need for a government policy on education to protect the countryside. The Conservation Corps., (now the National Conservation Volunteers) were formed in 1959 to give people the opportunity to actively participate in habitat management and protection.

The council of Nature was also formed and advertised the problems of wildlife through such activities as National Nature Week 1963. The media took up the banner, and programmes concerning all aspects of the countryside and conservation now form a significant part of television and radio output.

In May 1963 the Council for Nature and The Observer newspaper held a Wildlife Exhibition. It highlighted the lack of leadership, collaboration and official policy towards countryside conservation. This was noticed by the Council's patron, HRH The Duke of Edinburgh, who initiated a series of study conferences entitled 'The Countryside in 1970'.

The first of these conferences, held in 1963, gathered representatives from over ninety organisations and many reports, policy decisions, and surveys followed. One of the decisions made was to call a conference at Keele University in March 1965. It was here that the term 'environmental education' was heard for the first time in Britain, although it had been in use in the United States for many years. It was also agreed that an understanding of the environment was so important that it should become part of the education of everybody.

In all, seventeen recommendations were made concerning the actions of schools, colleges, and local authorities. Two of these are of particular concern to teachers:

"1) The education system should provide a wider understanding of the natural environment as a contribution to the cultural values of a liberal education and as an essential basis for the conservation and enhancement of the countryside.

2) The education of children should be enriched by making full use of the resources of the countryside wherever possible and appropriate."

(Environmental Education Report No. 9.)

It is widely accepted (Carson; D.E.S. Review; Martin & Wheeler) that the modern environmental movement began as a result of this conference. Their recommendations led to the forming of the Council for Environmental Education in 1968. Its' purpose was to provide a focal point for the co-ordination of projects and organisations, and to act as a distribution point for advice and resources. In other words, it was to provide the machinery to assist the growth of environmental education in England and Wales. At the same time a Committee on Education and the Countryside was created to do a similar job in Scotland.

The Plowden Report of 1967, 'Children and their Primary Schools', emphasised the value of using the environment and so, at all levels of education, teachers began to introduce new environmental studies courses. This, in turn, produced difficulties in the definition of the term 'environmental studies' and its' relationship to environmental education and varying academic disciplines. Carson (1977) defines it simply as 'applied studies of the environment' but it is an argument which has never been fully resolved and will be returned to later in the text.

The acceptance of a need for environmental education led to a curriculum development phase which started in 1961 with the establishment of the Nuffield Science Teaching Project and is still continuing today.

The Nuffield project produced sets of materials to be used in any way the teacher wished to promote scientific experimentation and thinking. The work started with 'O' level projects following on to an 'A' level syllabus. These projects produced a radical rethink in the way science, and its' related subjects could be taught in schools.

In 1964 work started on Nuffield Junior Science and a great deal of time was spent in schools finding out how children learnt. The aim was to help teachers, through project publications, to become more expert in promoting enquiry among young children. Although the materials produced contained some excellent ideas, the take-up of the project was not as high as was hoped. Ingle and Jennings (1981) produce three possible barriers to progress:

1) A lack of primary teachers with adequate expertise in the understanding and teaching of science.

2) The attitude of training colleges where science education is too often treated as an optional study.

3) A general lack of support by the advisory services in many areas of the country.

The Schools Council responded to the need for curriculum development in environmental and science education by initiating several major projects. The Science 5/13 project was specifically aimed at the primary sector and was another attempt to produce materials and ideas. Great reliance was placed on the need to identify objectives and relate them to children's development. These were explained in considerable detail in 'With Objectives in Mind' (Ennever and Harlen 1972) and about twenty source books were produced for teachers to use according to their own circumstances.

The difficulties here concerned the selection of activities from the books and matching them to the levels of development of the children. Ingle and Jennings again sum it up:

"Even a rapid perusal of the Science 5/13 materials indicates that great demands are being made on teachers, especially those who have no formal qualifications and little, if any, training in science."

In 1979 the Schools Council 'Learning Through Science' project was initiated with the main aim of producing materials for teachers and pupils to show how the Science 5/13 ideas might be used.

Alongside the curriculum development work the Society for Environmental Education was founded (1968) as the first teachers' association solely concerned with the use of the environment for educational purposes.

In 1970 the National Rural Studies Association was renamed the National Association for Environmental Education and has since become the major teachers' organisation.

Also during this time higher education establishments were introducing new courses in environmental science and environmental studies. Sometimes they were courses in their own right or, more often, elements within a degree course.

Some of the most rapid developments were in the growth of field studies and outdoor education. This was done through the provision of field study centres by local authorities; another recommendation from 'The Countryside in 1970' conference.

The use of the countryside increased greatly but there was concern that more should be done to teach young people about the urban environment. In response to this the Town and Country Planning Association set up a campaign for urban studies in schools through their journal; the Bulletin of Environmental Education. This resulted in a growth of urban studies centres to complement the field studies centres.

The word 'environment' was given official blessing in 1970 when the government created a 'Department of the Environment.' Its' job was, and still is, to act as government spokesman and co-ordinate policy on subjects relating to the environment.

Taking a more global view, 1970 was also significant in the U.S.A. as it became the first country to pass an Environmental Education Act. In the same year the International Union for the Conservation of Nature and National Resources (I.U.C.N.) held a conference in Nevada at which the following working definition of environmental education was proposed:

"Environmental education is the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate interrelatedness among man, his culture, and his biophysical surroundings. Environmental education also entails practice in decision-making and the self-formulation of a code of behaviour about issues concerning environmental quality."

The conference further agreed that

"......... environmental education was a science-orientated, multi-disciplinary subject where most, if not all, school subjects could, and should be, incorporated."

(Martin and Wheeler 1975)

The United Nations Conference on the Human Environment was held in Stockholm in 1972 and focussed world attention on human and ecological environmental issues. It was agreed to produce some broad guidelines for governments and a World Action Plan for the Environment was approved. The conference recommended that an international programme in environmental education should be established.

In 1975, arising out of the Stockholm conference, there was an International Environmental Education Workshop in Belgrade. This was organised jointly by the United

Nations Environment Programme (U.N.E.P.). It produced the Belgrade Charter - a global framework of environmental education. Regional meetings that followed led up to a conference which has been described by the Director General of U.N.E.S.C.O., as both a milestone and a staring point.

Tbilisi, the capital of the Soviet Republic of Georgia, was to be the venue in 1977 for the first intergovernmental conference at ministerial level. It was attended by over eighty international organisations, the purpose being to devise a plan of action through which environmental education could be developed at both regional and national level. Environmental education was described as a life-long process affecting all ages and socio-economic groups and should start when the learner is young, even pre-primary school age. It urged the formation or strengthening of co-ordinating bodies involving teachers, representatives of environmental protection authorities, and the media. Educators across all levels of education should continue resources to produce a common core of interdisciplinary environmental studies education.

All of this would need the full support and backing of the governments concerned and the Tbilisi Declaration was accepted by the UK government who recognised the need for improved and expanded environmental education in Britain.

Since Tbilisi there have been a number of important events; the I.U.C.N.'s World Conservation Strategy, launched in 1980, and the European Conference of Environmental Education in Berne, also 1980, to name but two.

All this high-level activity serves to reinforce the point that the principle of environmental education is now accepted throughout the world as being of vital importance to the future of the human race within the natural world. What has yet to happen is a cohesive strategy which produces the sort of environmental education programme recommended at the Tbilisi conference.

The content of such an environmental programme is cause for argument as many people are still not sure what is meant by the term 'environmental education.'

There are semantic problems in the use of this term, particularly concerning the relationship between science education and environmental education. Lucas (1980) argues that environmental education can be classified into three sections: education ABOUT the environment, education FOR the environment, and education IN the environment.

Education about the environment is concerned with providing cognitive understanding, including the skills necessary to develop that understanding. Education for the environment is directed towards the preservation of environmental diversity or its improvement for particular purposes. Both of these are characterised by their aims, but education in (or from) the environment is characterised by a technique of instruction.

The proportion of actual science inputted into an environmental education programme will depend upon the intended bias of the course or syllabus but, whatever the emphasis, the use of scientific methods and thinking are essential.

It is the last of Lucas's three distinctions, education in the environment, which, arguably, has the most relevance for primary education. It is an area into which many science disciplines can be incorporated, making it an excellent vehicle for integrated science work. Therefore 'science in the environment' or Environmental Science (defined by McB. Carson (1978) as 'Studies of the biological and physical elements of the environment') can be an essential tool for skills and knowledge acquisition and development at primary level.

This concurs with Collis' (1978) ideas on the broad areas of experience which should be available to primary children.

1) Observing and following changes in living and growing things, including themselves and others.

2) Handling, testing, and using a wide range of materials.

3) Listening to a wide variety of sounds.

4) Investigating numerical and spatial situations.

5) Making comparisons, looking at differences and similarities.

6) Practising healthy habits.

7) Discovering that other people have needs and opinions as a result of taking part in co-operative activities.

8) Gaining skill in the use of language through listening, speaking and writing.

Ingle and Jennings (1981) go further by saying:

"At the primary stage, science education is probably most effective when integrated with other activities. It should above all encourage curiosity about the natural world and channel that curiosity into satisfaction and enjoyment in carrying out investigations and in developing the skills of talking, writing, observation, measurement, and recording."

This epistemology of modern primary education is a function of the ideas which started with Rousseau, and evolved through the philosophies of Pestalozzi, Froebel, Montessori and Dewey. Knowledge is seen as man-made and in a state of continuous evolution; it is subject to constant modification and revision in the light of the emergence of new data from new experiences.

Thought of in this way, knowledge can only be acquired through experience and so, experience should be the kingpin of the educative process. The basic method of education is, therefore, problem-solving; the framing and testing of hypotheses, and the teacher's role is that of the guidance of the child through structured experiences to develop knowledge and understanding.

This view of education does not restrict it to what goes on during the years of schooling, but is a lifelong process of developing and modifying knowledge in the light of new experiences.

Such an approach, once described as 'progressive', has become characteristic of English primary education, even though it may not be manifest in all primary schools. In the words of Blenkin & Kelly (1981)

"these principles are now enshrined in the folklore of Primary Education."

The work of the major figures in the field of developmental psychology in the last fifty years, particularly

Jean Piaget and Jerome Bruner has provided tangible evidence to enhance the growth towards this view of education and the curriculum.

Piaget's work suggests that children pass gradually through developmental stages in their thought processes and that, although these stages are in a particular order, the rate of change between stages varies from child to child.

A four or five year old child coming into a reception infant class is probably still at the stage of pre-operational thought. His thoughts are representations of actions actually performed, or objects he has had contact with, and are centred on himself. There is an irreversibility of actions at this stage which could be described as pre-logical.

On entering the lower junior classes at the age of 7, the child has probably moved towards the next stage; concrete operational thought.

This stage, described by Piaget as 'logico - mathematical', dominates the child's progress through the primary school. He is capable of manipulating things, both practically and mentally, but it is always within the reference of his own concrete experiences. Towards the end of this stage there is a limited ability to hypothesise but full hypothetico-deductive thought does not appear until around the age of thirteen. Only when the learner has demonstrated the ability to manipulate concepts and ideas, and extrapolate from the concrete can he be said to be in Piagets final development stage; formal operational thought.

It is clear that if this theory of development is accepted, then the teacher must plan work to take into account the childs' stage of conceptual understanding.

The age of development from one stage to the next, and the extent to which individual young people and adults are able to employ deductive reasoning, has been a cause for fierce debate. However, it is accepted that, at the very least, Piaget's theory has shown that the developing thought processes of children in primary schools are dependent on references to practical situations.

The work of Jerome Bruner in the 1960's was concerned that any theory of cognitive development should be interlinked to theories of knowledge and instruction. He stressed the importance of the process by which human beings increase their mastery in achieving and using knowledge. The learner's actions should be directed at resolving problems presented by the environment and hence to a structuring and restructuring of his own view of the world. Bruner argues that the learner is constantly employing strategies in an attempt to understand the complexities of the world around him, and by studying these strategies (which he called 'modes'), the teacher can select one appropriate to the current level of understanding of the learner, and to the knowledge or skill to be learned.

Bruner identified three such modes: the first is through action (the enactive mode), the second through visual or other sensory organisation (the iconic mode), and the third is through words or language (the symbolic mode). These modes are sequential and have a powerful influence on mental activity at different ages. Each mode is not exclusive of the others and so complex interactions occur as the learner matures in his intellectual activity.

The main function of the teacher can then be seen as one of helping the learner to structure and recode his experiences in order to gain the greatest benefit in terms of understanding. The education process is then concerned with finding an effective methodology to facilitate this.

The dissemination of both Piaget and Bruner's theories throughout the primary curriculum has been instrumental in the acceptance of the need for child-centred education.

They also form a powerful argument for the teaching of science; the empirical methods applied in science are equally true of all aspects of the curriculum so, a general educational philosophy based on the work of the developmental psychologists in conjunction with ideas of the 'progressive thinkers', is not very different from the scientific approach to problem-solving. The skills involved concern those of observation, questioning, experimenting and reasoning, and ways need to be found of structuring these experiences into a matrix of knowledge.

The answer to the question "Why do science?" is already partly answered but more specific reasons are succinctly outlined in the Schools Council Science 5/13 publication "Learning Through Science" (1980). As they are an adequate summary of current thought, the author feels at liberty to quote them in full. The general arguments in favour of science are that:

"1) A practical investigation of the environment, in the widest sense and meaning of the word, involves purposeful reconnaisance and collection of specimens and data that deserve further study. Such study will involve development of skills. Children will begin to learn the use of measuring and magnifying devices. They will become aware that tests must be fair and results must be checked for accuracy and validity. Material must be arranged in ways that reveal its significance. These are objectives likely to stimulate critical thinking and proper respect for evidence in support of findings. Pursuit of such aims can help children to become accustomed to forming independent judgements.

2) The teaching and acquisition of scientific knowledge and methods is essential in preparing children for life in a highly technical and rapidly changing world.

3) Science can enrich other major areas of the curriculum. It provides a basis for planning, arguing and speculation, thus helping language development by providing children with concrete experience of many words and allowing for detailed description. Natural and man-made phenomena are a constant source of inspiration to creative expression. Mathematics is often necessary to allow scientific investigation to proceed.

4) The rising world population and man's insatiable demands for energy are making it essential for everybody to develop reasonable attitudes towards the state of the environment, and make wise use of its natural resources. Such caring attitudes cannot be forced, they can only come slowly through repeated encouragement."

The fourth reason returns the argument to the case for environmental science. The natural interest that children have in their outdoor surroundings can provide that valuable first-hand experience which is so vital for the meaningful investigation of problems. Such first-hand learning can only be successful through a foundation of sensory awareness and this can only proceed from a training in observing, listening and responding to experience with all the senses; the same training which offers a basic grounding for scientific study. To gain this experience from the environment is the basis of learning and provoking thought.

Colin Kefford in "Environmental Education - Principles and Practice" (1978) suggests that learning is motivated by four needs. The desire to find out about, make sense of, tell others about, and make judgements about. If these are to be satisfied they require the inter-related practices of exploration, interpretation, communication and evaluation.

These, in turn, produce a variety of skills, all of which can be more than adequately catered for in an environmental science curriculum:

Exploration:	observing
	calculating
	measuring
	asking
	reading
	collecting etc.
Interpretation:	moving
	playing
	arranging
	imagining etc.
Communication:	speaking
	writing
	recording
	displaying etc.
Evaluation:	discriminating
	believing
	behaving
	judging
	forming attitudes etc.

In summary then, the case for teaching environmental science as a subject in schools is put unequivocally by considering an overview of its historical evolution. This social and moral need is further reinforced by the fact that the methods of study used to carryout such work employs an approach which is directly in line with the modern philosophy of primary education in England.

These ideas are patently manifest in the N.A.E.E.'s 'Statement of Aims for Primary Schools':

"At the primary stage environmental education is seen as involving pupils in personal experience of the environment by direct exploration with all their senses, using the school and its' immediate surrounds and going further afield when necessary. Such environments will involve both the living environment in small nature reserves, school gardens, or in the countryside, and the build environment in streetwork. At this stage emphasis should be placed on the development and deepening of concepts. Teachers are expected to use these experiences to develop language in all its' aspects, numeracy, scientific methods of enquiry, aesthetic appreciation and creative expression as well as to encourage the development of value judgements and an environmental ethic. Children at this stage should be introduced to the statutory and accepted codes of environmental behaviour."

The case study which follows takes the example of one primary school in Lincolnshire which tried to fulfill this 'environmental ethic' and traces the development of first, a suitable school site and second, a curriculum for environmental science activities.

CHAPTER 2

Environmental Sciences in a Lincolnshire primary school: a case study

"At the primary stage environmental education is seen as involving pupils in personal experiences of the environment by direct exploration. In other words - we would like to see children out of the classroom whenever appropriate; first of all in the immediate surrounds of their school............

We would encourage all schools to set aside a small area as a nature reserve, and to do this properly by...... having it managed in the approved fashion. This reserve should be designed to encourage wild plant and animal life of all sorts. The area should be an immediate source of live biological material............

The environment does not stop there of course. The earth, rocks, stones and soil are available to be studied, not only what lies locally but what can be brought from further away."

(S.McB. Carson in 'Environmental Education - Key Issues of the Future 1977)

PHASE 1 - History, Objectives, and Planning.

Deeping St. James County Primary School is situated in a large village, 8 miles north of Peterborough, in the agricultural setting of fenland Lincolnshire. It was build in 1968 and, at present, has approximately 450 children on roll.

Plate 1 - Aerial view

When the school was built topsoil was piled up into a mound on part of the school site covering approximately one third of an acre. This was initially grassed over and used as part of the playing field.

The headmaster had always been an advocate of environmental work at primary level and so this area, known colloquially as "The Mound" was then designated as an area to be developed as a resource for this work.

A large concrete work area was built in which three, small, pre-formed fibre-glass ponds were set and an area of the grass was left unmown. Houses back on to the area so a line of Cupressocyparis Leylandii was planted to act as a screen.

Over the years a successfull breeding population of the common frog, Rana temporaria, was established and much useful observational, written, and art work was produced as a result.

Plate 2 - The original site

As the school roll increased, the limitations of 'The Mound' became obvious as it was too small in size to sustain the amount of work which should have been taking place. Use of the area became intermittent and restricted to occasional projects organised by interested class teachers.

It was realised that if the resource was to be optimised, it would have to be extended and modified. This was the point at which the author was asked by the headteacher to develop her ideas and, after much discussion, preliminary aims and objectives were agreed and a plan formulated for redeveloping the site to facilitate and support the proposed expansion.

The first stage of planning was to make a statement of broad educational aims, the overall aim being to develop an enquiring mind and a scientific approach to problems. This was to be done within a variety of controlled semi-natural habitats, thus allowing children to learn to appreciate and respect the environment as a whole and to provide initial training towards the 'environmental ethic' which the author considers to be so important.

The development of a scientific approach to problems is the beginning of the 'scientific method'; the basic elements of which can be logically ordered in the following way:

1) Observation
2) Asking questions
3) Proposing a hypothesis
4) Testing the hypothesis
5) Drawing conclusions
6) Discussion

The environmental science area was planned to be the vehicle through which motivation and situations are created for the development of these skills.

Coming from this main aim are the following sub-aims and developments:

1) developing interests, attitudes and aesthetic awareness.
2) observing, exploring, and ordering of observations.
3) developing basic concepts and logical thinking.
4) posing questions and devising experiments or investigations to answer them.
5) acquiring knowledge and learning skills.
6) communicating in a variety of ways.
7) appreciating patterns and relationships.
8) interpreting findings critically.
9) finding the most suitable method of recording available.
10) being involved practically in the management and control of the various habitats, leading to an appreciation of the needs of conservation and land use.

Aims 1-9 coincide with the broad aims stated in the Science 5/13 scheme, and are a useful statement of what it is hoped to achieve in all primary science work.

Work in environmental science can incorporate all these aims and add the extra dimension of working with living systems.

By this time it was clear that the educational implications predetermined the implementation of a major project. It was proposed to construct ecologically different habitats, including a moving water system, in conjunction with increased site access.

Plate 3 - The site for the pond system.

Money and expert advice was going to be required if the scheme was to be successful. It also seemed necessary that, in view of the amount of construction work to be done, there was an opportunity to employ someone on a full time basis. Thus, with local authority backing, the school applied for, and was awarded a selective temporary employment scheme. (S.T.E.P.) This would provide three people with work for six months in conjunction with a grant towards essential materials. However, for various reasons (mainly concerning the rules of who could be employed) this fell through and the project was delayed for nearly a year.

In order to expedite the project, it was realised that a self-help scheme was the only possibility using voluntary labour. The school does not have a P.T.A., as such, but has always received enthusiastic help and support from parents. An appeal was sent out, therefore, for manpower and materials. The response was good and forecast logistics were favourable.

An appeal was also sent to local firms and many were most supportive concerning building materials and plant. Some donated materials or loan of equipment whereas others allowed materials to be purchased at cost price, or less.

Expert advice was sought, discussions developed, and advice was freely given concerning the ecology of the proposed habitats and the factors which had to be taken into account during construction. A list of acknowledgements appears at the beginning but the amount of enthusiasm and interest generated was encouraging and rewarding.

The only missing, but vital factor, was money. Being a large school, fund-raising events in the past had been well supported, and so it was decided to have a sponsored tables test. This was the first event of its kind the school had organised so the outcome could not be predicted. It was, however, an outstanding success and almost £1800 pounds was raised. This gave an upper limit for the total cost of the project.

PHASE 2 - Construction and Stocking.

Work started in February 1980 and was completed in October 1981 after concentrated efforts by groups of parents and staff working evenings, most weekends, and some holidays. When possible, the children also helped out and made very efficient and responsible labourers. The opportunity to don wellies and jeans and get very dirty was often preferred to playing the usual games with friends!

The enthusiasm of the people involved increased as new skills were learned and existing knowledge was applied to a new situation. It became a personal 'quest' to complete the task in hand to the highest possible standard. As a public relations exercise alone it was a great success and generated much goodwill and co-operation. To cite an example: one family used to bring a packed lunch every weekend, much to the delight of their children who thought it was great fun to picnic at school!

Fig 1. Shows a plan of the site before building work started. Mobile 5 had been taken away leaving a bare space which was designated for the chequerboard garden. To create this paving slabs were laid alternately leaving a gap the size of a slab between each one. This produced a 'mini-garden', totally separated from other plots which can be used for seed growth experiments and the teaching of basic gardening techniques.

Two seats were placed along one side and a geological garden was constructed along the other. This has taken the form of rock specimens set into concrete, the specimens having been collected during the course of previous school trips. They were sorted according to basic type, i.e. limestone, granite, slate etc., before being cemented in position. This gives an instant reference to the types of rocks likely to be encountered locally, and on school trips.

The third side of the chequerboard garden was utilised as a tree plantation. Approximately 70 seedlings of indigenous species, namely Quercus robur (pendunculate oak), Crataegus monogyna (English hawthorn), and Fraxinus excelsior (common ash), which were donated by the Nature Conservancy Council. They were planted by groups of children and a continuous check is being kept on rate of growth and general welfare. They are now between 1 - 1.5m high.

Plate 4 - The chequerboard garden

PLAN 1 - The Original Site

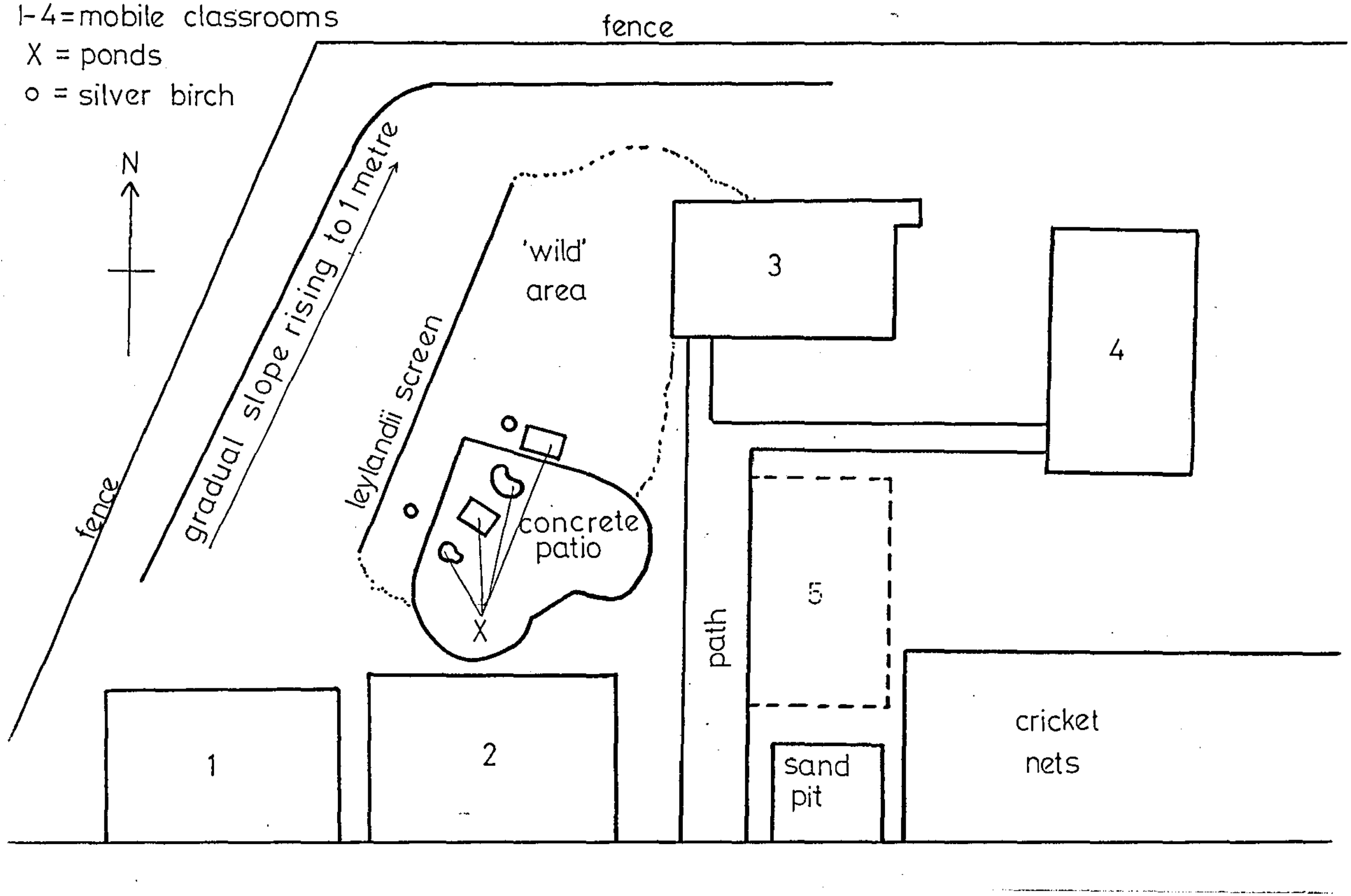
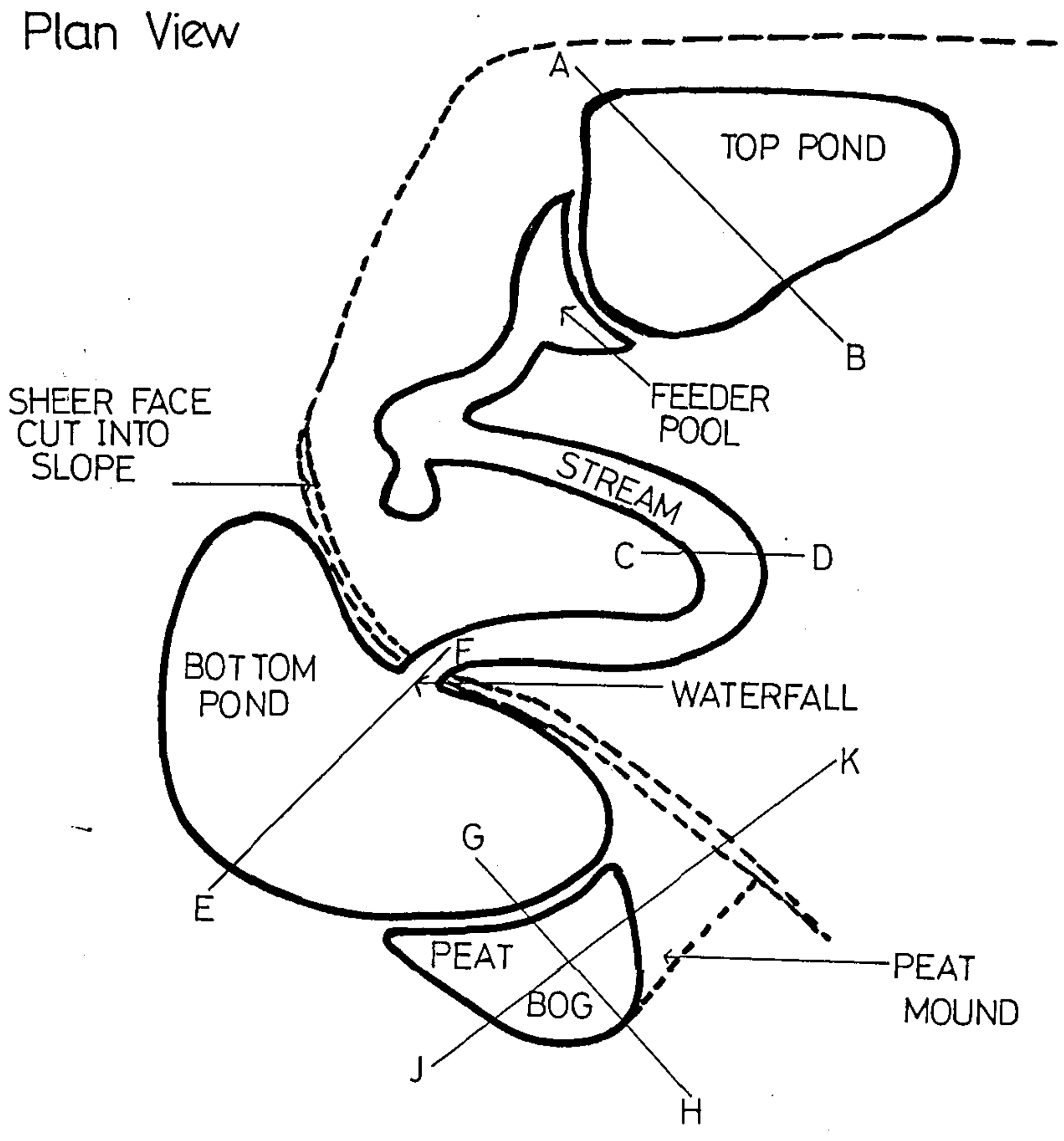


Fig. 1

POND SYSTEM



The feeder pool will be 1m. higher than the bottom pond. The water will flow along a stream, down a slight slope, precipitating into the bottom pond and then pumped back up to the feeder pool.

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Fig. 2

It had been decided from the start to build the ponds in concrete, on the grounds of both permanency and child-proofness, and their construction, therefore, represented a major task. After much discussion it was decided to build them as a saucer shape. This removed any need for the complicated and costly shuttering arrangements of the sort that would be required for stepped levels. Soil trapping levels were produced by cementing layers of bricks at appropriate depths on the sloping sides.

The plan for the pond system is shown in Fig. 2. Utilisation of the existing slope made it possible to construct two ponds, one a metre higher than the other, linked by a stream and waterfall. The circuit was completed using a water recirculation pump. It was thus possible to create a variety of aquatic habitats involving both still and moving water. The original population of Rana temporaria adopted the new ponds in the first season and were joined by Triturus vulgaris, the smooth newt.

Fish have been introduced into the lower of the two ponds, notably, Rutilus rutilus (roach), Scardinius erythrophthalmus (rudd), Tinca tinca (tench), and Gasterosteus aculeatus (stickleback).

The ponds were also planted up using indigenous plant species in keeping with the general policy of producing as natural a habitat as possible.

Plate 5 - The top pond

Plate 6 - The stream

Plate 7 - The bottom pond

Constructing the bottom pond involved cutting into the slope of the bank which created a sheer wall. This has been faced with large limestone blocks fitted together with a minimum of mortar to encourage plants to colonise the crevices.

Plate 8 - The limestone wall

Next to, but separate from the bottom pond a small area (i.e. 1.5m square) was constructed to be utilised as an acid bog. It was build of concrete but lined with a thick commercial pond liner to ensure that no lime from the concrete leached into the water. It was next filled with Sphagnum moss (of the type purchased in garden centres) over which living sections of Sphagnum bog were placed. This has produced a habitat quite different from anything that can be encountered in the surrounding countryside, and given an opportunity to study the plant communities in an impoverished soil. This type of habitat is encountered by the 4th year juniors on their school trip to the Lake District.

The final water-based system was an area of wetland created to demonstrate the type of habitat likely to be found in The Fens before drainage and cultivation. This consists of a large hole (4m x 6m) lined with plastic sheeting and puddled clay and filled with fen peat, donated by the N.C.C. from local peat excavations. This has been stocked with typical fen plants such as the osier, Salix viminalis, common reed, Phragmites communis and various rushes (Juncus spp), and sedges (Carex spp.).

Plate 9 - The peat bog

Plate 10 - The fen marsh

One of the main problems with small water systems is water loss through evaporation and transpiration. In the school situation this danger is at its height during the holidays and thus, action was taken to minimise the chance of the ponds drying up.

After some consultation, a semi-automatic watering system was devised. (For details see appendix I.) The aim was to collect excess water during wet periods to store for use in dry periods. As the level of water in the ponds drops, the stored water is fed into the system automatically to compensate. Overflow pipes at strategic points also ensure that an excess of water in the system is drained off into the fen marsh.

The final major construction was the creation of a well-drained alkaline area, a limestone mound. This was achieved by laying a foundation of rubble and limestone chippings over which was placed a mound of top-soil mixed in a 1:1 ratio with powdered lime. This was then immediately sown with Creeping Red Fescue, Festuca rubra to stabilise the soil. Various seeds of calcicole plants were sown and the area now has a flora resembling that of a calcereous heath. For example: the cowslip (Primula veris), salad burnet (Poterium sanguisorba), quaking grass (Briza minor), and ribwort plantain (Plantago lanceolata) are all flourishing.

Plate 11 - The Limestone mound

One further development occurred in the summer of 1980 when mobiles 3 and 4 were removed as, due to a fall in roll, they were surplus to requirements. The space left by mobile 4 was adjacent to the football pitch and was reclaimed as part of the school playing field. The space left by mobile 3 was sown with a commercially produced grass/wild flower seed mix. This is only mown biannually, in early spring and late autumn, giving the effect of a flower-rich meadow.

To finish off the scheme it was necessary to have easy access to the different habitats to enable the children to observe, sample, and record in reasonable comfort. A compromise had to be struck between what was ecologically desirable and educationally sensible. Importantly, due consideration had to be shown to the school cleaning staff, continual deposits of mud and grass could quickly lead to ill-feeling and antagonism.

With these factors in mind, the 'wet' areas were surrounded by crazy-paving paths which serve the dual purpose of keeping footwear relatively clean and trampling pressure to a minimum.

Fig. 3 shows the completed scheme. Full details of construction, showing the plans and stages of development, can be found in Appendix I.

It is vital on a system of this complexity to have a simple, but effective, management policy. If specific action is not taken at certain times of the year then, eventually, the distinct habitats will become overgrown by the very invasive weeds of cultivation. So often, in schools where ponds and environmental areas have been produced, this important fact is forgotten and so, through neglect and ignorance, the resource is lost.

It is also important that everyone in the school is aware of this policy in order that the responsibility should not fall upon one person but should be shared. This helps to bring a common understanding towards the need for habitat management in order to preserve a resource and is a very important concept in conservation. It is a widespread fallacy that conservation means 'leaving alone' when, in reality, true conservation is the active management of an area to produce a desired habitat.

The active involvement of all concerned is also an insurance policy to enable the resource to continue. It ensures that the management continues regardless of staff

PLAN 2 - The Completed Project

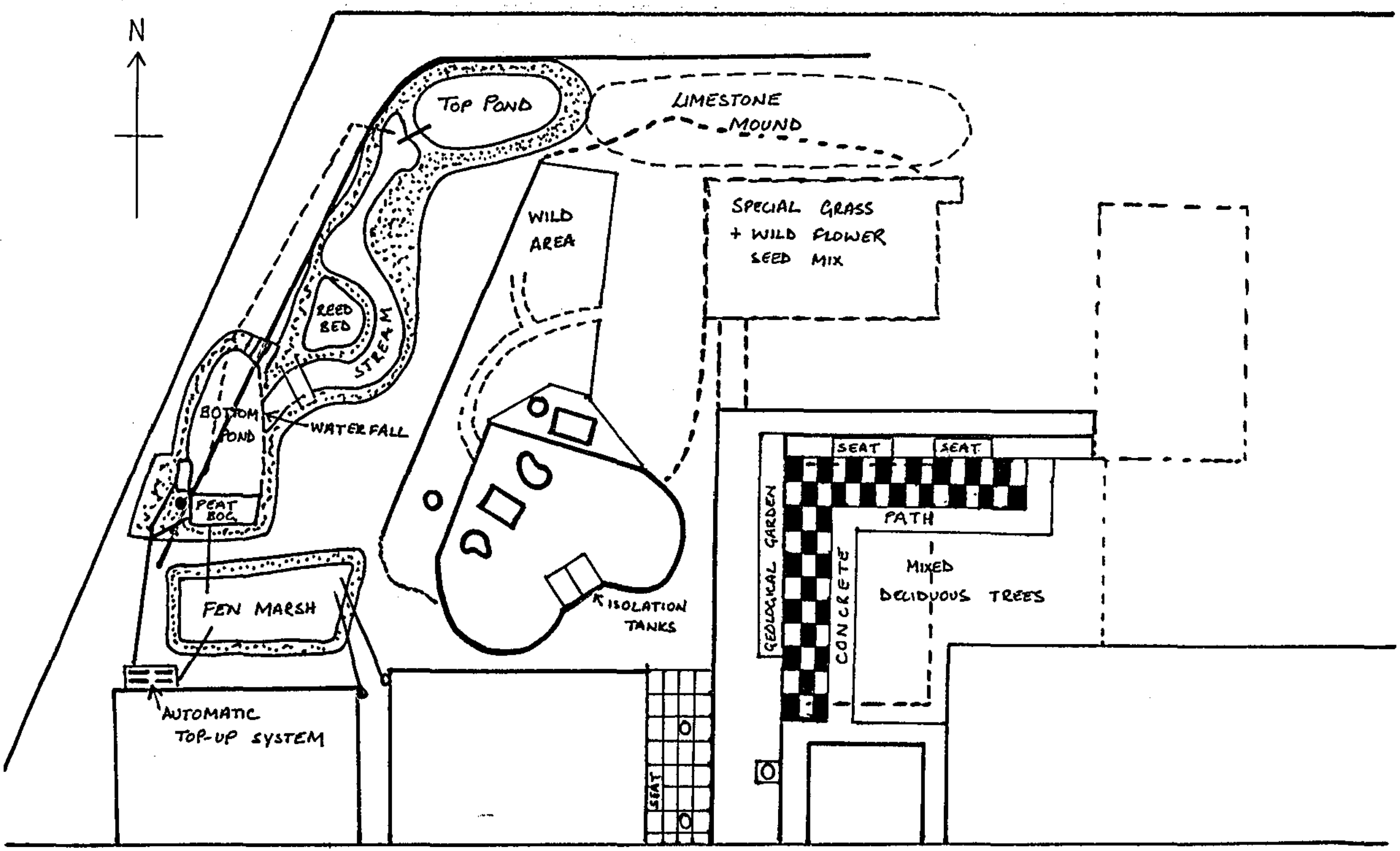

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Fig. 3

and pupil changes.

The full management policy can be read in Appendix II. This was finally drawn up by the author using her own experience of practical conservation, reading through management schedules produced by the N.C.C. for their nature reserves, and talking to people involved in the theory and practice of habitat management.

A document as important as this cannot be static. Reviews of the habitats have to be undertaken from time to time and alterations to the management policy made, if the desired effect has not been achieved.

PHASE 3 - Curriculum Development & Use of Site.

Although the author has separated out habitat construction and curriculum development, the two were occurring concurrently. The successional development of the environmental science area in ecological time and diversity terms was paralleled by and equivalent expansion in curriculum activity and diversity. This, in turn, produced an increase in interest in environmental science work by both staff and pupils.

This can be shown diagrammatically within the time sequence of 4 years. (See Table 1.)

There was an initial period of discussion and planning during which the author compiled a list of topics which would be applicable in terms of the aims and objectives set out previously. It was therefore necessary to discern the suitability of these topics with regards to appropriateness for the age and development of the children concerned. The timetable was organised in such a way that the author worked with all four junior year groups for one hour per week. This was difficult from the point of view of follow-up work but did give a valuable opportunity to judge the level and effectiveness of environmental science-based topics, and to predict the equipment and resources required.

After two years of weekly sessions, the author felt confident to introduce suitable topics into ordinary class time. There followed a period of discussion between the

Table 1	SITE CONSTRUCTION	CURRICULUM DESIGN & USAGE
		Educational aims and objectives defined.
Year 1	Discussion & planning	Discussion & planning
	Assimilation of advice on construction & ecology	Initial trial topics taught by the author
Year 2	Construction (Appendix I)	discussion with collegues as to suitability of topics
	planting up	development of these topics into curriculum guidelines
	path laying	
Year 3	extensive use of site by whole school	introduction of curriculum
		discussion & evaluation
Year 4	long-term management policy drawn up (Appendix II)	production of interpretative and resource materials (figs 4 - 16)

author and the class teachers concerned, explaining ideas for suitable work, the equipment and resources available, and their use. Ideally it would have been most desirable for the author to work alongside the class teacher during the introductory phase, but, being a full-time class-teacher herself, it was not feasible. Further information, advice and expertise were, however, dispensed whenever necessary.

The introduction of the work scheme into the curriculum took a further two years. Each year group has a suggested curriculum from which the class teacher can select or expand topics. If the general themes for each year are maintained, each child will experience a wide variety of environmental science activities and have the opportunity to acquire sound observational, investigative, and experimental skills which can then be applied to other areas of the curriculum. The importance of this was commented upon by H.M. Inspecorate in their discussion booklet 'A View of the Curriculum'.

"Learning about the nature of materials and about the needs and life-cycles of plants and animals provides further opportunities for the extension and application of language, and of mathematical skills and ideas. It also helps children to appreciate the world around them and provides an early introduction to the industrial and scientific age in which they live."

The following pages set out the curriculum framework. Although, at first glance, the author may be accused of producing a watered-down biology syllabus, it must be stressed, that the emphasis lies not simply in the inculcation of a body of knowledge, but in providing a vehicle for a scientific approach to problems. The class teacher should not feel pressured to cover all of the subjects suggested, but to ensure that the work chosen fulfills the already stated aims and objectives.

Two examples can be cited to illustrate how this work might proceed.

During a pond dip a group of 10 year olds remarked on the very large number of snails that were being netted. "There must be millions!" said one boy. His friends disagreed but the argument initiated an investigation into how to estimate the population of pond snails. This kept them occupied for several weeks whilst they faced the problems of standard sampling, finding the volume of water in the pond, and deciding what sort of 'sums' would be required to find an answer. The eventual answer of 3,126 snails seemed plausible.

An exercise of this nature is an excellent example of a scientific approach to a problem which manifested itself from a chance remark. Each stage of the basic elements of the 'scientific method' is represented:

1) Observation: the large number of snails being caught.
2) Asking questions: an argument about the number of snails present.
3) Proposing a hypothesis: how many snails are there?
4) Testing the hypothesis: devising methods for sampling and counting.
5) Drawing conclusions: finding an estimate of the population.
6) Discussion: did this agree with their original remarks concerning population size?

On another occasion a group of 11 year olds were trying to make a list of plants growing in specific habitats. When they studied the acid peat bog they noticed that the water was teeming with tiny creatures whereas this did not appear to be the case in the larger ponds. This observation led them into a study of plankton. They sampled all the different water bodies on the site, using a standard measure, and counted the numbers and types of plankton in each sample. Speculations were then made as to why there were such marked differences. Some quickly suggested light and weed conditions and even water acidity (work had been done earlier in the year on soil acidity) but it was only after more careful consideration that the suggestion was made that there were creatures in the ponds which might eat the plankton which were not present in the other sample areas. This was then tested by setting up two plankton-rich aquaria. Pond animals were introduced into one but not the other, and, sure enough, after several days the population of plankton in the aquaria with animals in had drastically reduced whereas there was no apparent change in the other tank.

Here the scientific approach was taken a stage further in complexity and sophistication. A controlled experiment was set up in the classroom to test a hypothesis from which definite conclusions could be drawn. The understanding of the importance of the concept of testing, checking, and repetative measurement are absolutely fundamental to any serious scientific inquiry and these children found very little difficulty in coping with these advanced ideas. It should be pointed out that this group consisted of children whose general scholastic ability would be described as 'average'. They were building upon their own experiences of science work undertaken in previous years to produce a very sound working method. This can only be achieved by carefully structured scientific opportunities, continuing from one year to the next. It should also be noted that this study was actually a digression from the main topic under discussion (i.e. plant habitats) and is therefore a good example of how a curriculum should be flexible to allow for such 'child generated' education to take place.

The following curriculum outlines give extensive opportunities for children to tackle the problems and concepts leading to a 'scientific method'.

In the infant department the emphasis is on observation, discussion, and simple writing and drawing. There are seven suggested activities which may be taken as topics, or used in conjunction with other work.

1) Observation and discussion of the frogs, spawn and tadpoles and their development through the various stages.
2) Observation and recognition of the other creatures in the ponds.
3) Investigation and discussion of plants from the point of view of shape, pattern, flower colour, leaves, bark, etc.
4) Observation of insects in the environment; butterflies, bees, ants etc.

5) Undertake a study of insect life under stones.
6) Observation and discussion of how plants attract insects and why.
7) Attempt to grow various plants and bulbs in the classroom under varying conditions.

Work of this nature gives opportunities for sound observation and discussion and it is often surprising just how much a young child can notice. Here are two extracts from stories written by a six and seven year old respectively after a visit to the ponds.

"Today we went to the school pond. We saw tadpoles and some frogspawn then we kept still. Suddenly we saw a frog. The frogspawn is like jelly and it has black dots in the middle of it. The black dot is the tadpole inside the egg. When the tadpole comes out of the egg it looks like a fish."

"The frog has two eye-lids. When the frog closes his eyes the middle eye-lid goes down but he can still see."

The infant scheme can also provide situations for some scientific investigation to take place, for example, in plant growth, but more quantitative work is not likely to start until the first year juniors.

This work is based around the ponds. They are responsible for the small ponds with respect to keeping them clear of litter and debris and (with adult help) removing excess plant growth. This work, and some of the observational work, is done in small groups with parental supervision. The study plan is likely to take the following format:

1) An introduction to the whole environmental science area in the form of a tour, plan, and an explanation of the areas they will be working on. (This links in with the maths scheme which involves simple plans and maps.)
2) Monitoring the daily temperature of the water and presenting the results as a simple graph.
3) On this graph marking the days when frogs were first seen, and when the first spawn appears.
4) Compiling a 'frog diary' recording any interesting

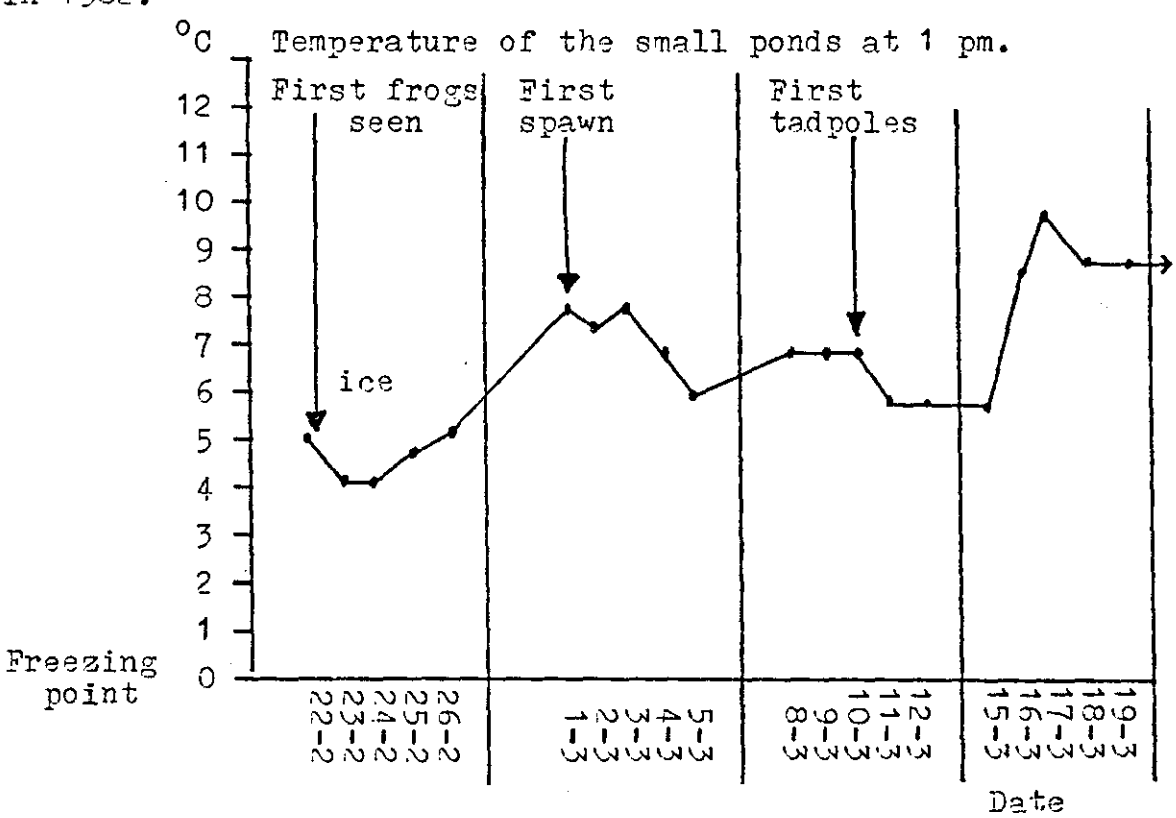
observations or information discovered.

5) Setting up an aquarium with developing tadpoles for more detailed studies and observations.

Here the children are introduced to several new and important skills: the safe handling and correct use of simple measuring equipment; the need for continuous measurement, and the regular recording of measurements and observations. As records are kept from year to year, it is also possible to make direct comparisons (see the section on interpretative and resource materials).

School policy encourages parents, and on many occasions they give invaluable help. They supervise small groups of children taking their measurements and making observations which are then processed back in the classroom. Each parent has his or her little group and so a pleasant working relationship is built up between them. The parents themselves become very interested in the children's work, a pattern which repeats itself throughout the school.

Here is a copy of a graph made by one first year boy in 1982:



This graph continues until the 2nd April, after which, no more adult frogs were recorded.

Plate 12 - Studying amphibians

In the second year plant biology is used as the subject base from which more skills can be learned.

In the autumn term seed heads from the nature reserve can be collected, sorted and (where possible) identified. Those deemed suitable can be labelled and stored dry until the spring. Other work can be done on seed production, dispersal methods, poisonous berries and fruits.

In the spring term seed growth experiments can be undertaken using mustard or cress seed to discover the basic requirements for germination.

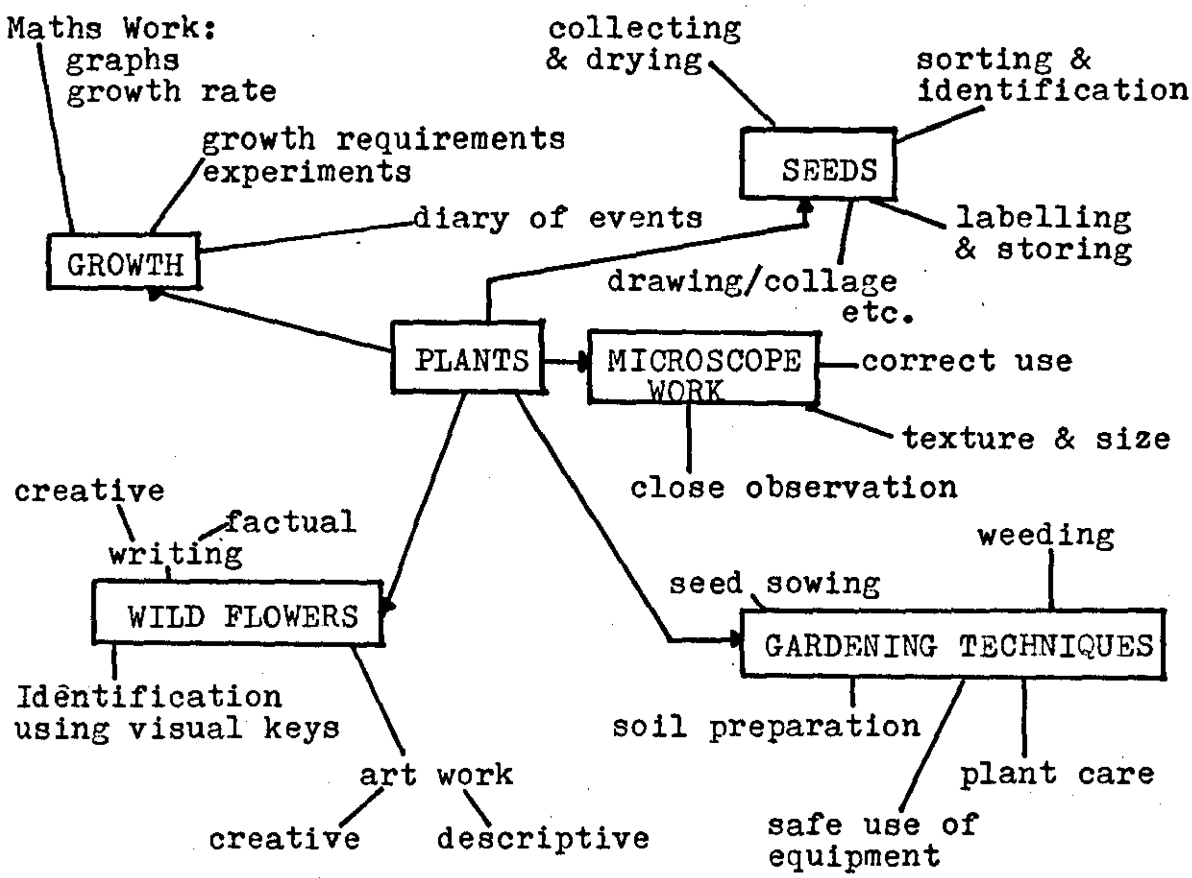
The seeds stored from last autumn can be set into trays and/or straight into the ground after the soil has been properly prepared.

The area designated for this work is the chequerboard garden.

In the summer term the seeds grown in trays can be planted out and growth of all plants is monitored. The class is divided up into small groups and each group is responsible for tending and weeding their own assigned plot.

During these activities, a regular check is kept on the other plants on the reserve as they come into flower.

One popular activity which fits nicely into this scheme is a sunflower growing competition. The seeds are saved from year to year and each second year child is responsible for their plant. The record so far stands at 2m 68cm, and the resulting seed head contained over 2,000 seeds! The second year work can be shown as a flow diagram:



The range of activities diversifies considerably, former skills are improved, and new ones introduced. Observational work includes the close scrutiny required to sort different seeds and to identify growing plants. This is further practised by use of microscopes to get an even closer view of the finer structures being studied.

Manipulative skills, some aspects of which require quite a delicate touch, are practised in gardening techniques and growth experiments. Measuring needs to become more precise in order to monitor growth rates of seedlings.

Controlled experiments to discover the basic requirements of plant growth are undertaken and, again, continuous measuring and recording becomes important.

The concept of continuous attention is reinforced further in the nurturing and care of plants and ensuring they have correct growing conditions.

An important example of how work can be linked across the age groups can be given here.

A group of fourth years became interested in how oil could be produced from plants and so persuaded the second years to let them have some of their surplus sunflower seeds. With the aid of a bookbinding press, they did succeed in extracting a small amount of sunflower oil. The fourth years then co-operated with the second years, combined their knowledge of the subject, and produced a joint project of their work.

Plate 13 - Gardening activities in progress

The third years are introduced to the arthropod kingdom and the theme is 'minibeasts'.

Methods of trapping, catching, and keeping specimens for further study can be introduced in the autumn term using pitfall traps, water traps, pooters, sweep nets etc.

The captures can first be sorted into main groups (i.e. beetles, spiders, flies etc.) using a visual key and then identified further (if required) using a dichotomous key, (Examples can be seen in figs. 4 - 8), and/or books. Instruction and practice in the use of keys can be done at this stage.

Results of trappings can be expressed graphically

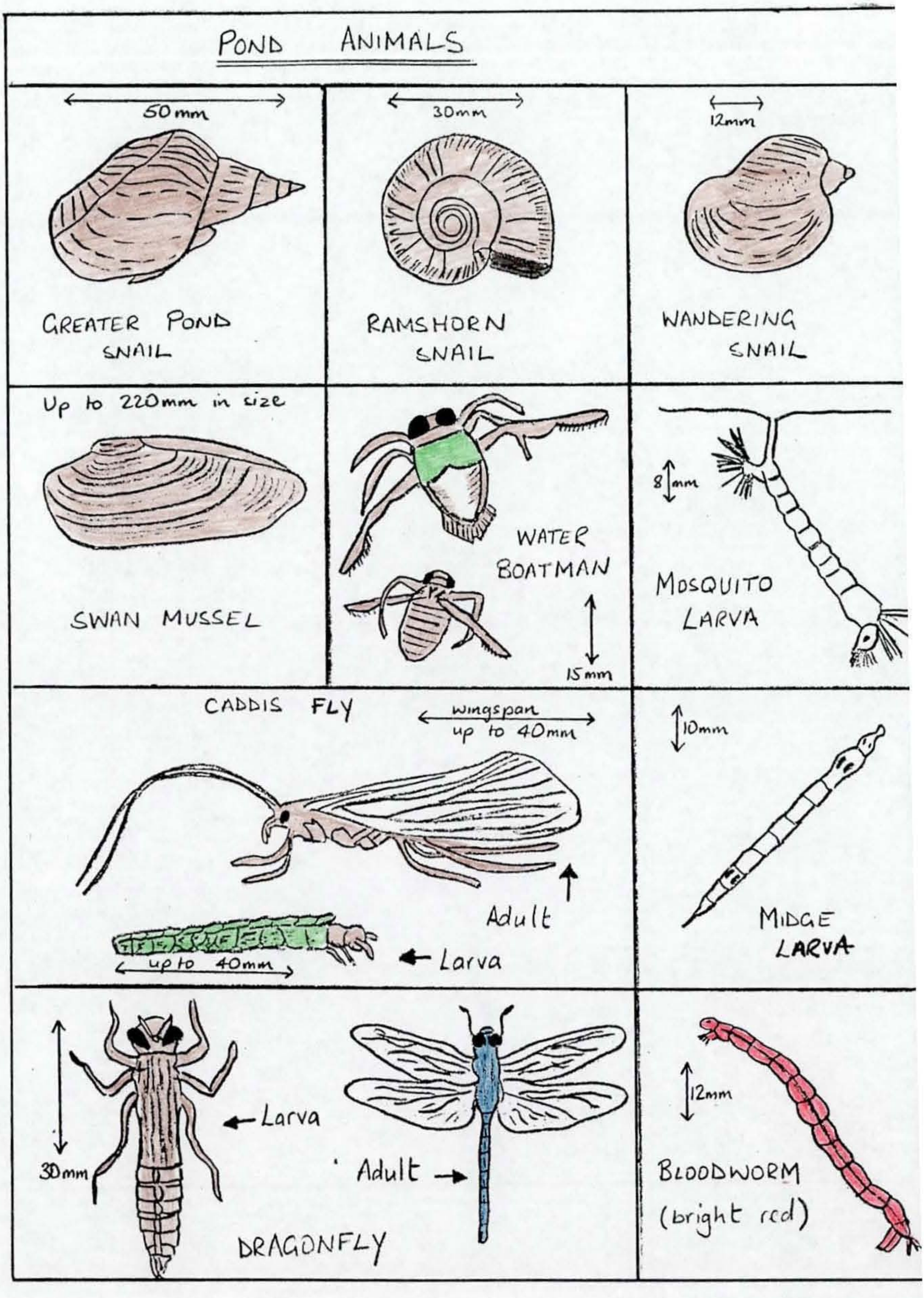

POND ANIMALS
50mm
GREATER POND SNAIL
30mm
RAMSHORN SNAIL
12mm
WANDERING SNAIL
Up to 220mm in size
SWAN MUSSEL
WATER BOATMAN
15mm
8mm
MOSQUITO LARVA
CADDIS FLY
wingspan up to 40mm
Adult
Larva
up to 40mm
10mm
MIDGE LARVA
30mm
Larva
Adult
DRAGONFLY
12mm
BLOODWORM (bright red)

Fig. 4

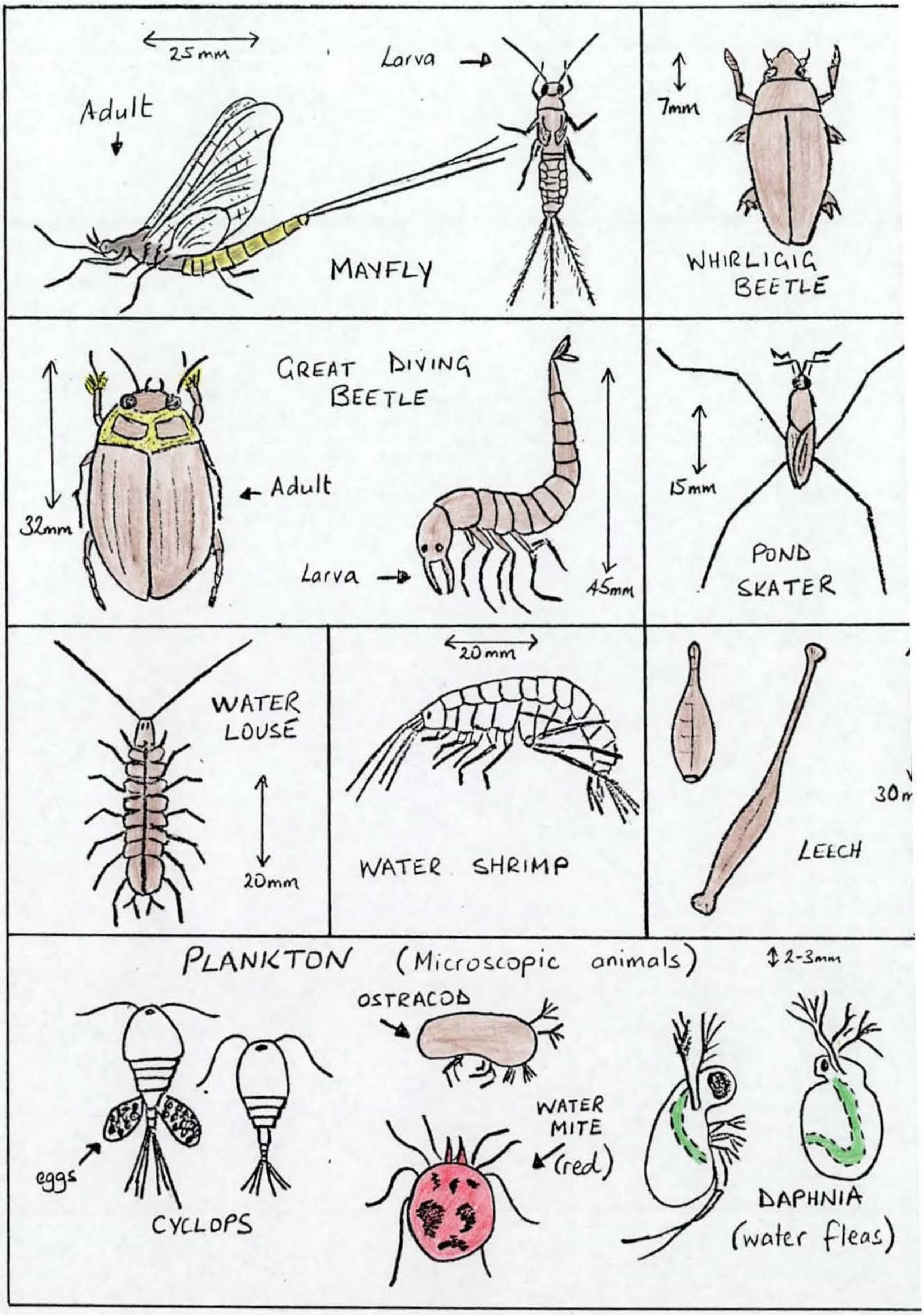

25mm
Adult
Larva
MAYFLY
7mm
WHIRLIGIG
BEETLE
GREAT DIVING
BEETLE
32mm
Adult
Larva
45mm
15mm
POND
SKATER
WATER
LOUSE
20mm
20mm
WATER SHRIMP
LEECH
PLANKTON (Microscopic animals)
2-3mm
OSTRACOD
WATER
MITE
(red)
eggs
CYCLOPS
DAPHNIA
(water fleas)

Fig. 5

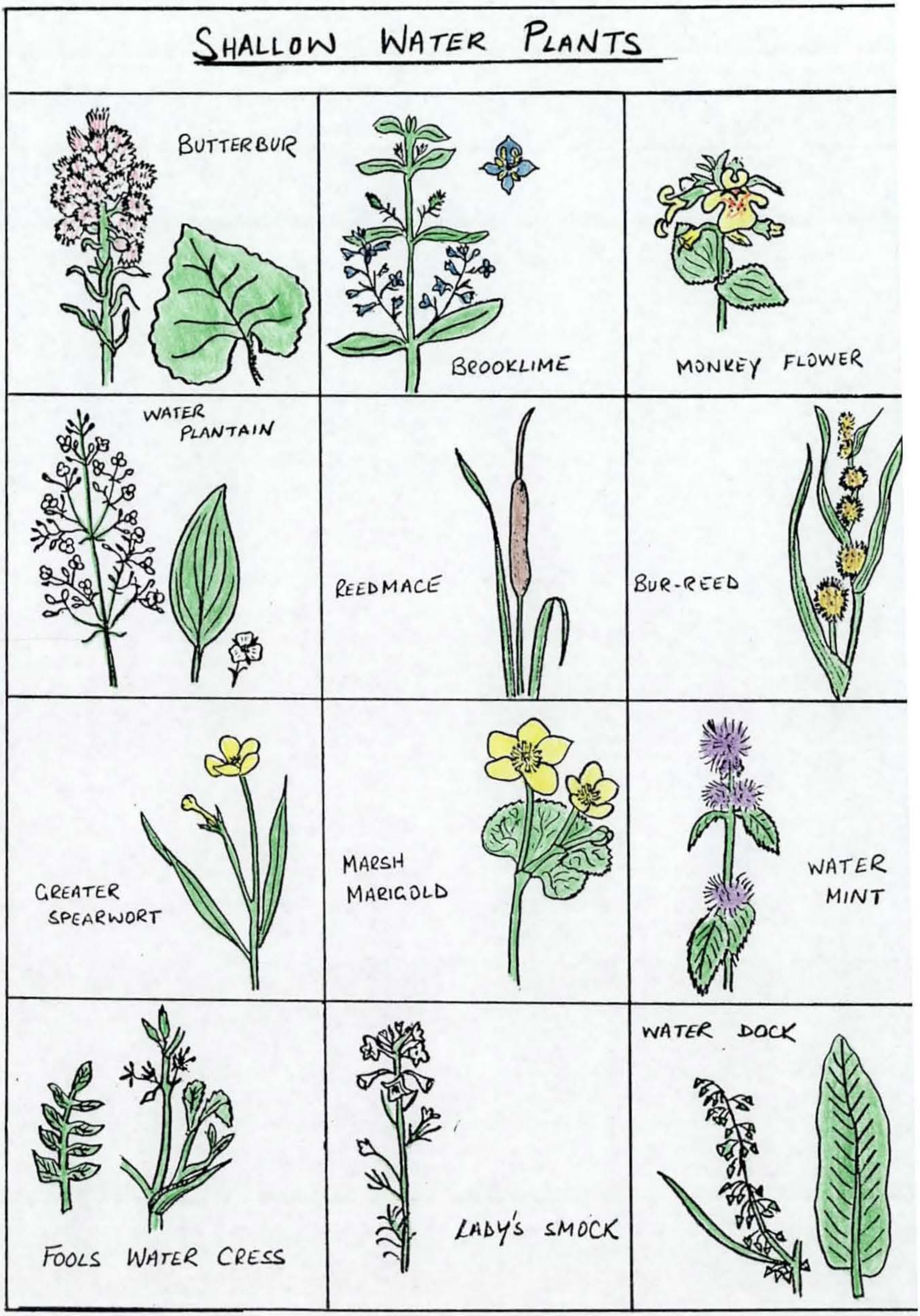

SHALLOW WATER PLANTS
BUTTERBUR
BROOKLIME
MONKEY FLOWER
WATER PLANTAIN
REEDMACE
BUR-REED
GREATER SPEARWORT
MARSH MARIGOLD
WATER MINT
FOOLS WATER CRESS
LADY'S SMOCK
WATER DOCK

Fig. 6

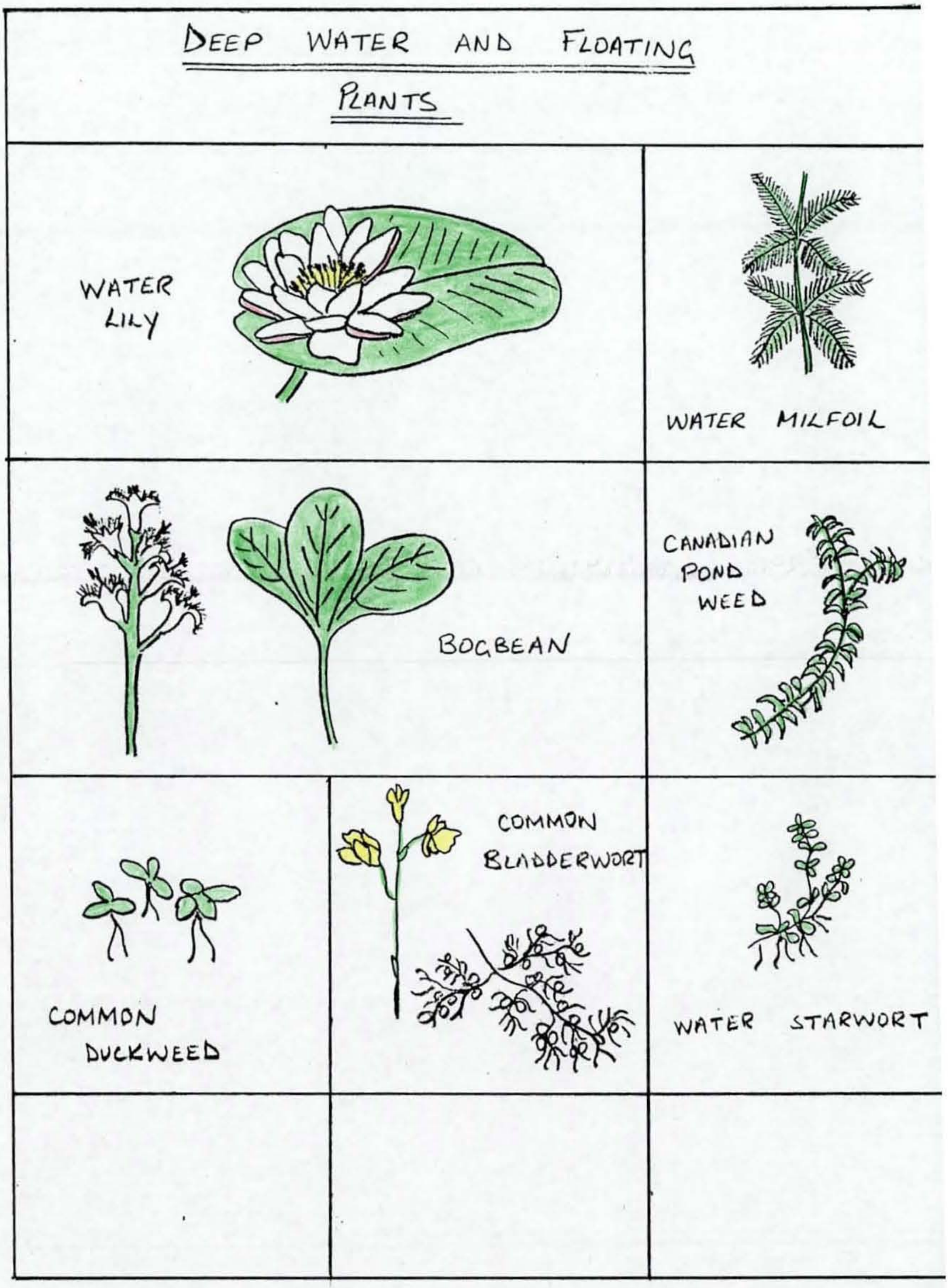

DEEP WATER AND FLOATING
PLANTS
WATER
LILY
WATER MILFOIL
BOGBEAN
CANADIAN
POND
WEED
COMMON
BLADDERWORT
COMMON
DUCKWEED
WATER STARWORT

Fig. 7

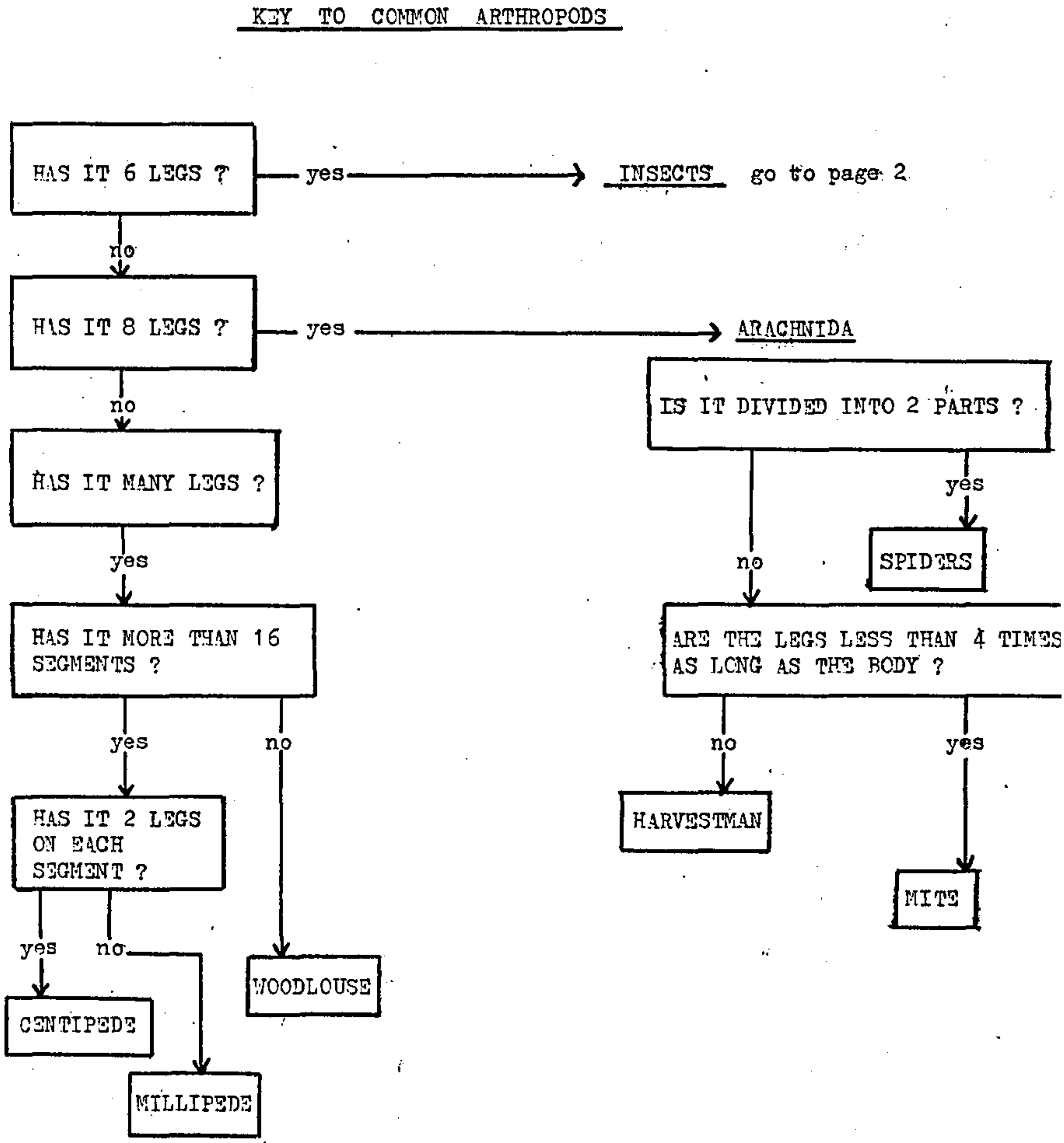


Fig. 8 - The first page of a typical dichotomous key.

and average results for successive trappings can be found.

A consideration of preferred habitats can be made, bringing in such ideas as, protection behaviour and camouflage.

Artwork, poems and stories can all be initiated from this work.

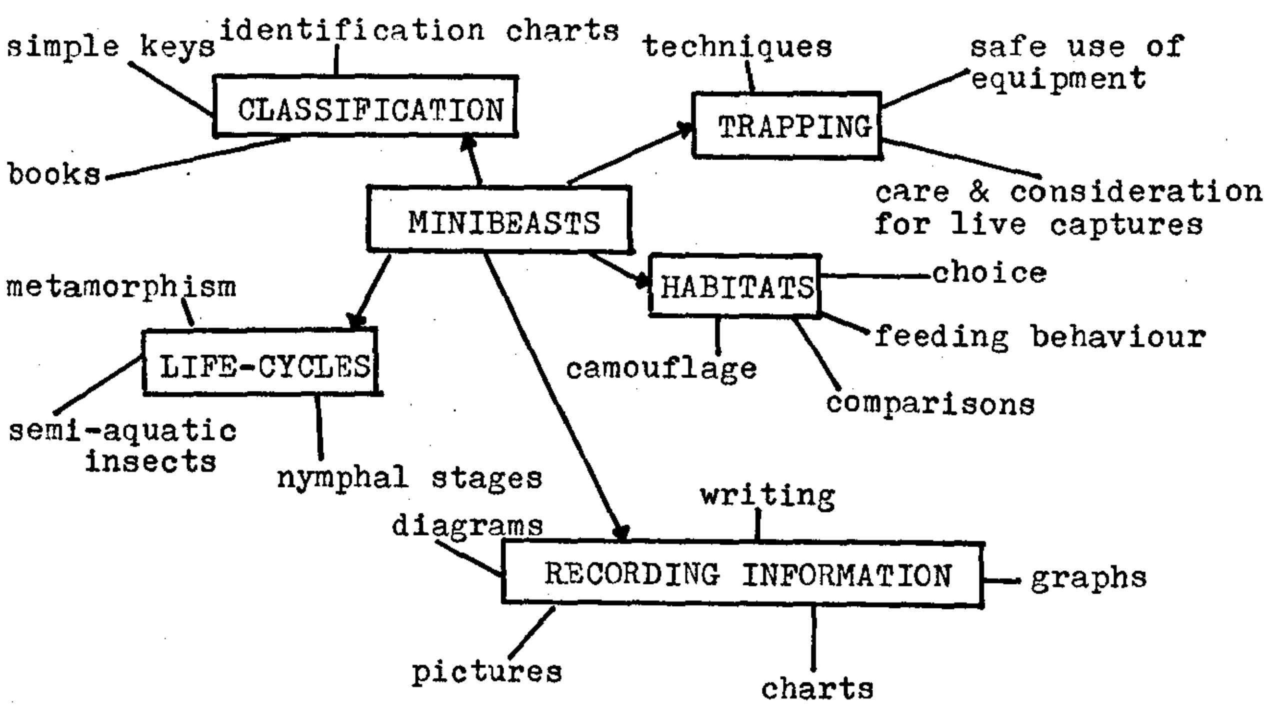
During the winter a foray into the environmental science area will reveal places where minibeasts are hibernating. This naturally leads into a consideration of arthropod life-cycles and adaptations to the cold.

In the summer term pond-dipping can be done to study aquatic minibeasts. Previous work on keys helps identification work. Some of the more obvious adaptations to water can be discussed, e.g. gills, breathing tubes, the 'oars' of the water boatman etc.

A minibeast hunt can be undertaken. Using the knowledge gained in the first term, the class could predict where they would expect to find certain minibeasts and then see if they were correct.

Later in the summer term it may be possible to carry out a butterfly survey. A route round the nature reserve is selected and walked regularly (e.g. twice a week), weather conditions are noted along with the number of species and the actual numbers seen.

Shown as a flow diagram, the third year scheme looks something like this:



This work has a heavy experimental bias and gives plenty of opportunities for sampling, measuring and collecting skills to be employed. A greater use of laboratory and field equipment becomes necessary and safe, responsible behaviour is essential to avoid accidents and breakages.

The data collected from these experiments will require more sophisticated processing, resulting in new graphical and mathematical skills.

Identification work becomes more detailed and the use of dichotomous, as well as visual, keys needs to be understood.

In almost everything tackled there are opportunities for questions to be asked, observations to be made and experimental design to be discussed.

Ideas concerning animal behaviour and adaptations are emerging, and theories can be tested by experimentation.

The example given earlier concerning pond snails shows a typical investigation.

Plate 14 - Pond dipping.

In the fourth year an attempt is made to come towards an understanding of the interdependence of living things and the preferences of some plants and animals to specific conditions. This is a drawing together of the threads of investigations carried out in previous years and building on acquired knowledge. The theme through which these habitats are studied is soil.

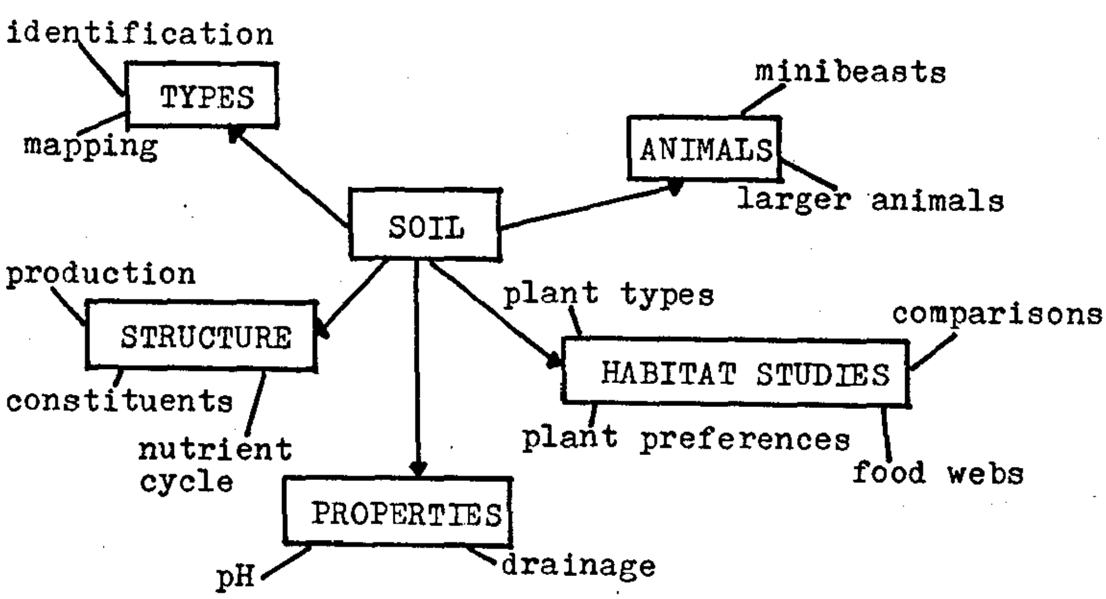
In the autumn term standard sized samples of soil are collected from different habitats on the nature reserve. These are then carefully sorted for minibeasts (a follow-on from 3rd year work) which are identified and counted. Working in groups, each group can make a graph of their results, then come together with other groups to combine results and/or make comparisons.

Work can be done on soil structure; how it was formed, and its main constituents. The different types of soil on the reserve can be identified using a dichotomous key and a map can be made showing the position of the different soils on the nature reserve.

In the spring term two properties of soil can be tested using simple laboratory equipment; acidity and drainage efficiency. This can lead to a discussion on how this might affect plants and animals.

In the summer term a 'plant diary' can be built up using identification sheets, showing which plants prefer which habitats (or which are not fussy), and when they flower. The different habitats can be compared in many ways for similarities and differences.

As a flow diagram, the fourth year work would take the following form:



However, this is only the bare skeleton of the work which can be covered and digressions into a variety of personal interests are possible, as the example, quoted earlier, of the plankton study shows.

By this stage children are manipulating equipment with a high degree of skill and are assimilating the concepts which are necessary for an understanding of the whole habitat. The ideas of food webs and nutrient cycles are forming. Some of the more able children are in a position to decide in what form to express their data and results.

Often their personal knowledge, through opportunities to follow up interests, can become prodigious and 'junior experts' have appeared on a wide range of subjects, from fungi to skulls.

To illustrate the range and diversity of work done by the fourth year, the author would like to give three, contrasting, examples. The first is by a girl who, inspired by the book 'Country Diary of an Edwardian Lady', decided to compile her own 'Nature Diary'.

" Spring Has Sprung!

30th April, 1983.

There has been a change in the weather. Where it was windy and cold it has become warm and slightly breezy. This has made a dramatic change in the ponds and surrounding vegetation.

The trees are in bloom. The flowering cherry is in full bloom. The blossom is pink and white. The leaf buds on the beech tree are just opening. Soon they will become full size leaves. The flowers of the silver birch are catkins. The tree has very tiny and sparse leaves at the moment.

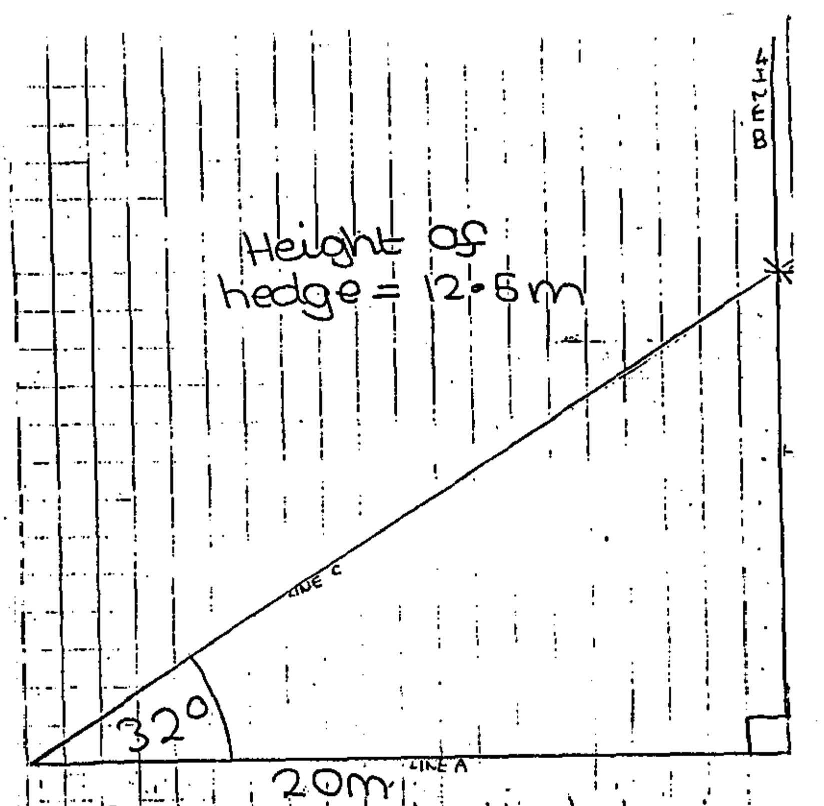
..............the dandelions and daises are flowering. A member of the clover family is black medick. It gets its' name because the seeds are black and it was used for medicine. Salad burnet is edible. The fern like leaves taste like bitter lettuce or cucumber.............."

This continues for several pages and includes observations and illustrations from the ponds and other areas. This was just one entry in a diary that continued weekly for three months.

The second example is the work of a boy who had not previously shown much interest in school work. The class were using clinometers to measure tree and hedge height; an activity which captured his interest and enthusiasm.

"We measured the height of the hedge at 0m, 6m, 12m, 18m, 24m. First we measured 20m from the hedge and put a pole in the ground. Then we got a clinometer and took it in turns to lay on the ground and measure the hedge. This was done by lining up the top of the plant with the top of the clinometer and pulling the trigger. When the pointer had stopped swinging you got the angle in degrees. When we had got 10 measures we added them all up and divided them by 10. Now we had an average angle to work out the height of the hedge. You draw a scale drawing. The easiest is 1cm = 1m. You draw a line of how far away you are from the hedge to scale. Then you draw in your average angle and draw a line going through the angle mark.

Here is an example. If your average reading was 32° this is what your drawing would look like

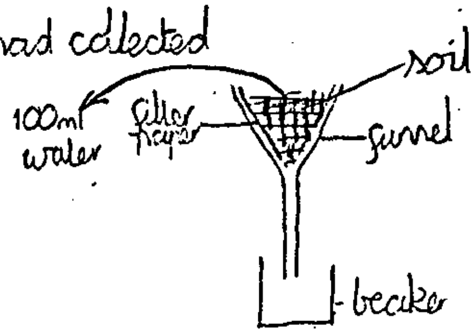


The final example shows three pages of children's work on soil. They cover three separate experiments; firstly, an investigation into the drainage properties of soil, secondly, a manipulation of litmus and universal indicator paper and the information this reveals concerning the acidity/alkalinity of liquids, and finally an application of this knowledge in the context of soil tests.

18th November Experiment to Test the Drainage of Different Soils

Method

First of all we folded the filter paper so it would fit in the funnel, then we measured 100ml of Soil and tipped it into the funnel The filter paper stopped it going through. Then we measured 100ml of wate At the same time putting a beaker under the funnel. Then we poured the water onto the soil and started the stopwatch. After 5 minutes we looked to see how much water was in the beaker. Then by taking away how much we had collected from 100ml we worked out how much the soil had collected



Results

Soil Type	Water added ml	water collected ml	water retained ml	Class Average
Lime	100	22	78	78ml
Peat	100	37	63	44ml
Sand	100	53	47	68ml
Loam	100	82	18	71ml

Conclusion

Lime retained the most water with 78ml, Loam retained 71ml, Sand 68ml, and Peat retained the least with 44ml. The amount of water retained in the soil relys on how big the particles are (see back page). For instance Peat has very big particles so water can't flow through easily

Acids And Alkalis

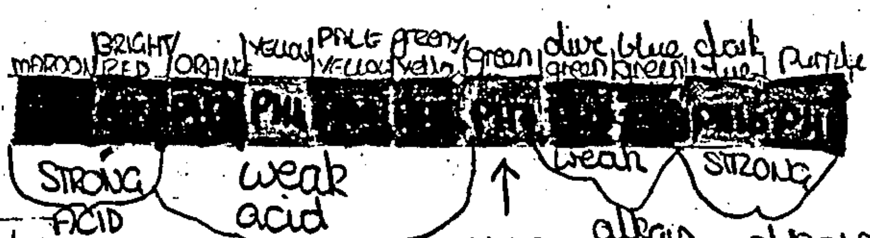
Litmus paper tells us whether something is acidic or alkaline

Blue → red = Acid
Red → blue = Alkali
No change = Neutral

Litmus paper does <u>not</u> tell us how strong the acid or alkaline is to do that we need to use

UNIVERSAL INDICATOR PAPER.

Universal indicator paper turns different colours depending on the strength of the liquid. We call it <u>PH rating</u> The lower the PH number the stronger the acid. The higher the PH number the stronger the alkali PH7 is neutral



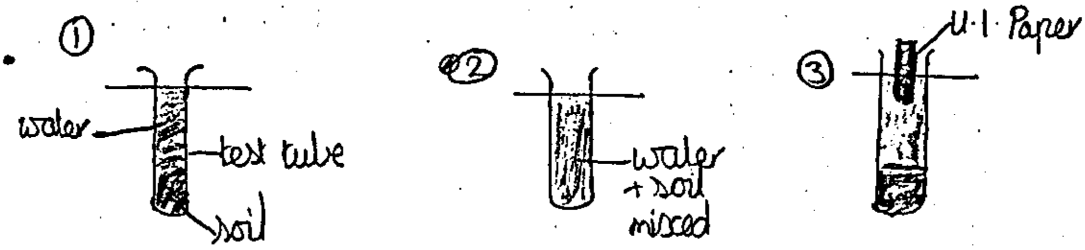
Liquid 1 - water
Liquid - Slaked lime
Liquid - Citric acid lemon juice

liquid one was PH7 it is neutral
Liquid two was PH10 it is alkalis
liquid three was PH3 it is weak acid

Experiment to test if soils are acid, alkaline or neutral

Method

We put some soil in a test tube with some water. We shook up the soil and water until they were thoroughly mixed. Then we left it to settle. After it had settled we dropped some universal indicator paper into the test tube and watched to see which colour it turned. The colour tells us how acid or alkaline the soil is. All the soil came from our nature reserve.



Results

	Soil Type	Colour of U.I paper	P.H	Acid/alkaline neutral
Chequerboard Garden	A Loam	dark green	9	w. alkaline
Sand Pit	B Sand	mid green	8	v. weak alkaline
Fen Marsh	C Peat	light green	7	neutral
Limestone mound	D Lime	light blue	9	alkaline
Peat Bog	E ~~Peat Bog~~	olive	7	neutral
Pond	~~F Pond~~	aqua	9	alkaline

Conclusion

We found out that Loam, Sand, Lime were alkaline and Peat was neutral.

✓

Plate 15 - Concentration is required to count plants for a frequency and distribution survey.

As mentioned before, there is plenty of opportunity within this curriculum structure to digress into whatever special interests are aroused in the children. Some become interested enough to join natural history clubs such as 'Watch' or the Young Ornithologists Club, and become very active within their local group. There is a school club which meets one night after school and during lunchtimes which is responsible for the maintainance of the various habitats. This involves them directly in conservation work and introduces the idea that land has to be managed to produce desired habitats. For larger maintainance jobs, for example pond clearance; parents are asked to help and there is usually no problem in finding a task force of willing volunteers.

The author also started a 'Watch' club (the junior branch of the Royal Society for Nature Conservation) within the school and parents and children attend regular meetings to places of interest within the area. These cover a range of activities such as bird watching, nature rambles, pond dipping, fungus forays, and badger watching.

Both of these clubs thrive but, by their very nature, can only involve a small proportion of children. The school, as a whole, has two residential trips involving all of the third and fourth year classes. These are not solely environmental science trips but could accurately be described as environmental studies trips where historical, geographical and social aspects are also taken into consideration.

The third years spend two nights at Bath youth hostel and three days exploring Bath, Bristol, and Cheddar Gorge. For the visit to Cheddar, preparatory and follow-up work is done on caves and cave-formation, and the birds and flowers they are likely to see whilst there are studied and discussed.

The fourth years go to the Lake District and spend three nights at Grasmere Youth Hostel. For this trip work is done on rock types and formation, minerals, flowerless plants (particularly mosses and ferns), and birds and flowers of the mountains. Direct reference can be made here to the plants growing in the acid peat bog and to the geological garden.

In conclusion then, what started as a strong belief in the educational importance of environmental science has evolved into a structured curriculum which can be used as a sound vehicle for skills acquisition. It allows children to work at their own level, often on their own interests; and gain valuable practical and experimental experience.

It is to be hoped that the following statement from the 1980 HMI paper has been fulfilled, at least in part.

"The development and use of opportunities, the special skills of teachers and enthusiasms of children should be used to enhance the quality of work beyond what might come from simply uniformity of practice, ...when teachers make good use of their particular interests and strengths, they can take children much further than is now common."

PHASE 4 - Development of Interpretive and Resource Material.

As the environmental science work got underway and projects were initiated it rapidly became obvious that the resources available, particularly books, were inadequate. There were sometimes insufficient books to support the work undertaken or, they fell into the categories of having either too much, or too little information. There was the added problem that books being expensive items, and primary school budgets being small, it was impractical to use them in situations where they might get damaged, i.e. outside, near water.

After much thought and discussion with colleagues, the author decided to attempt to produce material which would help to interpret the nature reserve. The basic aim was to produce simple visual identifications which could be used 'in situ' and were robust enough to be rained on, or accidentally dropped in the pond.

The first sheets covered pond life and pond plants, (refer figs. 4-7.)

The problem of making them strong and waterproof was solved by sticking them firmly to very thick card and covering them in transparent adhesive film. Before this was done they were coloured for easier identification. 20 copies of each were made, enough for a whole class to use. The master copies were kept as a resource for future replacements. The original sets have withstood the test of time as they have been in use now for three years with little sign of wear.

Encouraged by this success, further sets were produced for minibeasts, and flowerless plants (mosses, fungi, ferns and lichen). The latter also included information which would give a general introduction. Figures 9 and 10 give an example.

The plants of the nature reserve presented a greater challenge as over 60 species had already been recorded. The author decided to order them chronologically month by month, from March to July, the peak times of study. This still presented problems as many plants flower over a period of several months. A partial solution was to illustrate only the plants which had come into flower that month and to simply list the plants that were still flowering from the previous months sheet. Figures 11 and 12 give an example.

Although perfectly usable in this form, it does mean a

FUNGI

WARNING
NEVER attempt to eat any fungi and always wash your hands after touching them.

The fungus plant is a mass of white threads called HYPHAE. It grows and feeds on the remains of dead plants and animals. The part we usually see is called the FRUITING BODY containing SPORES. This is only produced at certain times of the year. The best time to find fungi is in the autumn but, if you look carefully, you can find some all the year round.

The best places to look are in damp, sheltered places or on dead tree stumps and branches.

Here is a diagram of a typical toadstool:

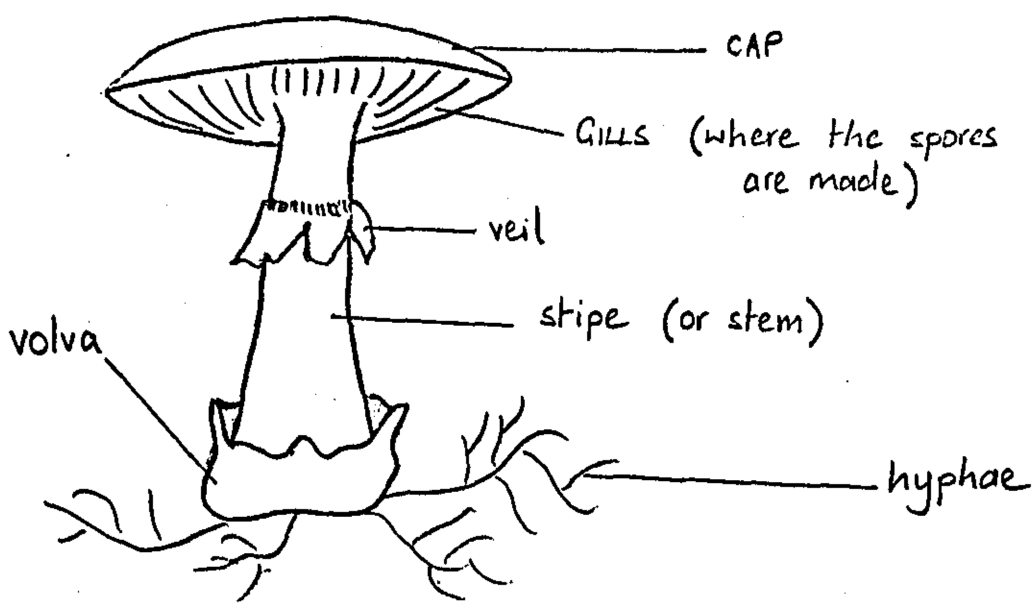


Fig. 9

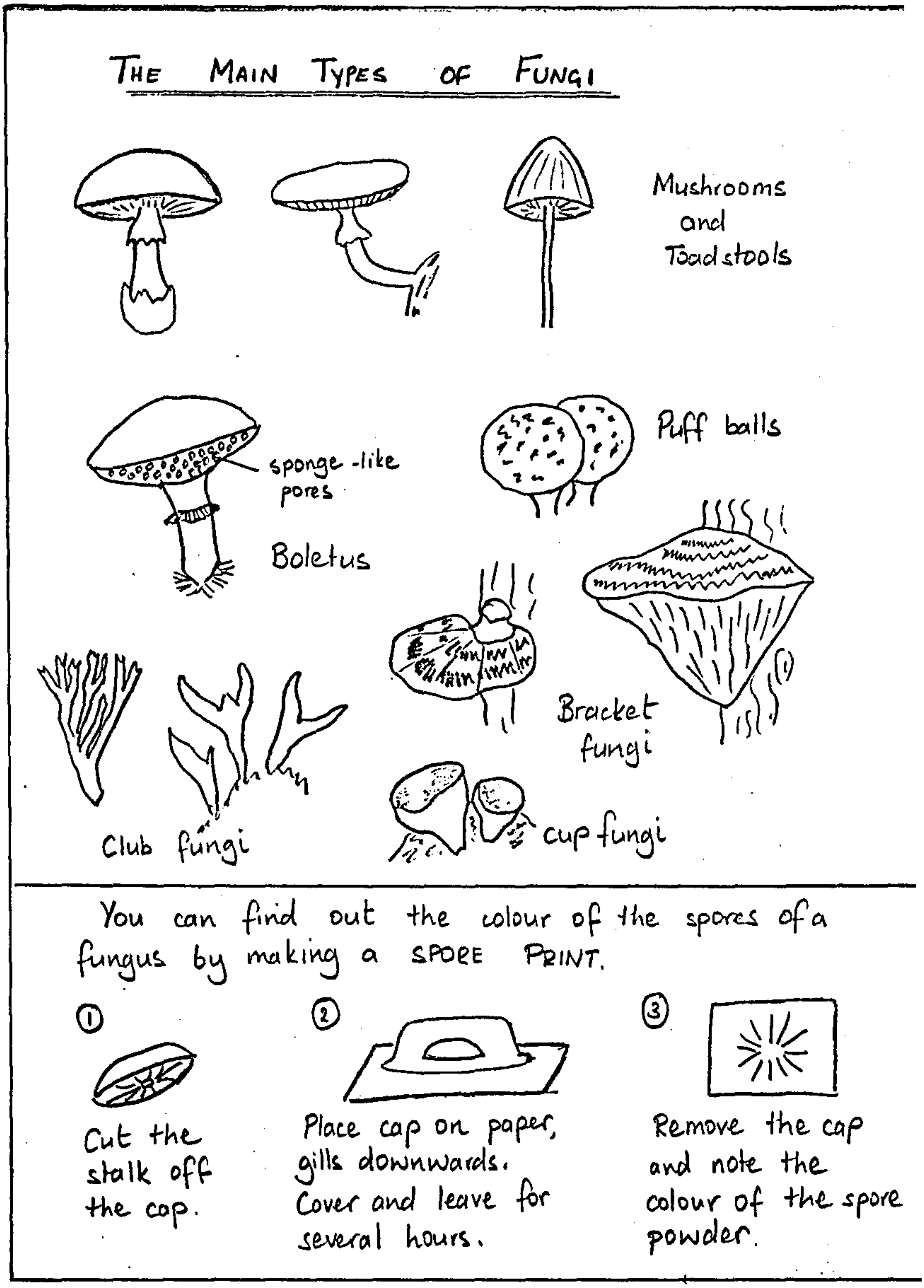

THE MAIN TYPES OF FUNGI
Mushrooms and Toadstools
sponge-like pores
Boletus
Puff balls
Bracket fungi
Club fungi
cup fungi
You can find out the colour of the spores of a fungus by making a SPORE PRINT.
① Cut the stalk off the cap.
② Place cap on paper, gills downwards. Cover and leave for several hours.
③ Remove the cap and note the colour of the spore powder.

Fig. 10

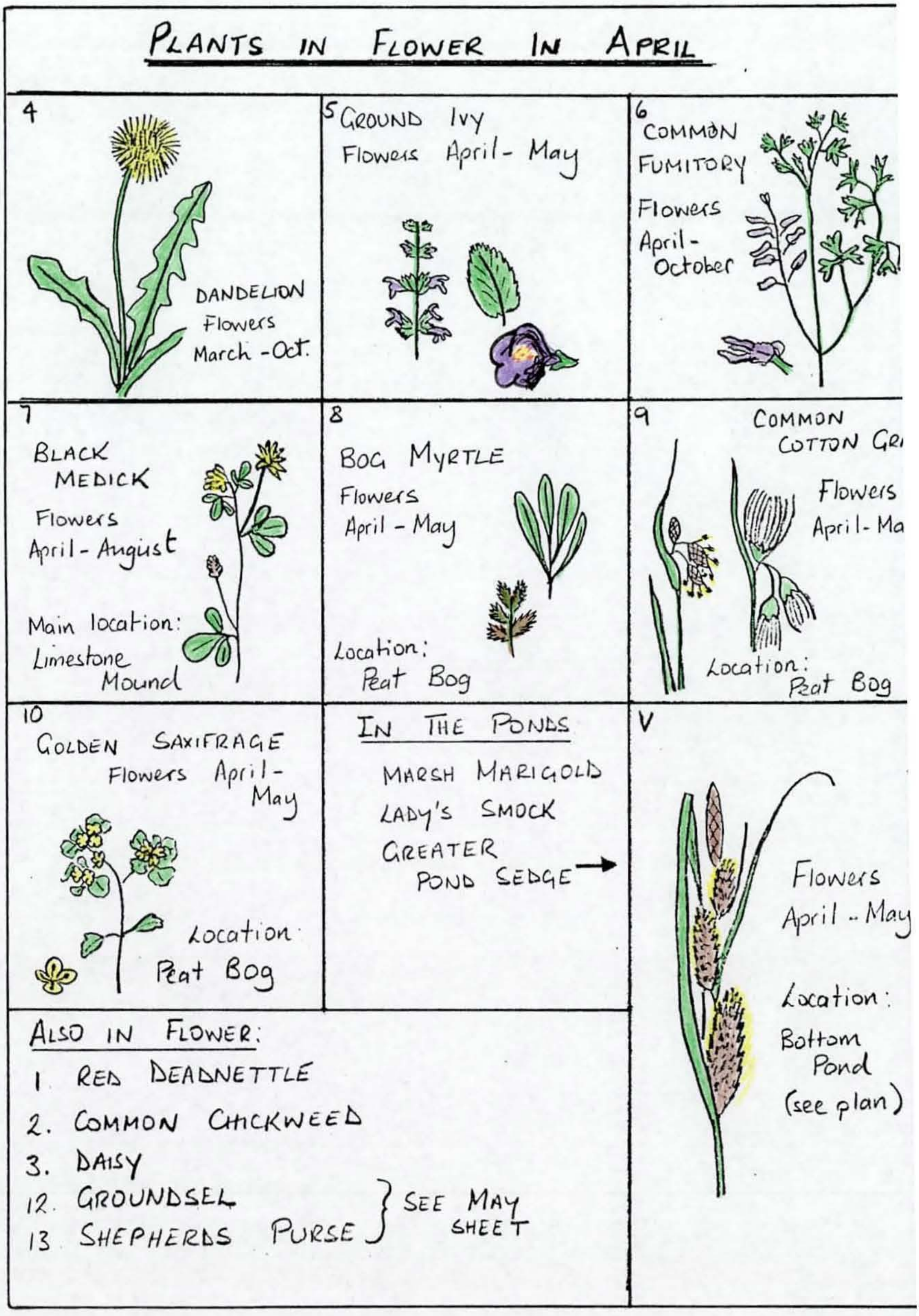

PLANTS IN FLOWER IN APRIL
4
DANDELION
Flowers
March -Oct.
5 GROUND IVY
Flowers April- May
6
COMMON
FUMITORY
Flowers
April -
October
7
BLACK
MEDICK
Flowers
April - August
Main location:
Limestone
Mound
8
BOG MYRTLE
Flowers
April - May
Location:
Peat Bog
9
COMMON
COTTON GR
Flowers
April - Ma
Location:
Peat Bog
10
GOLDEN SAXIFRAGE
Flowers April -
May
Location
Peat Bog
IN THE PONDS
MARSH MARIGOLD
LADY'S SMOCK
GREATER
POND SEDGE
V
Flowers
April - May
Location:
Bottom
Pond
(see plan)
ALSO IN FLOWER:
1 RED DEADNETTLE
2. COMMON CHICKWEED
3. DAISY
12. GROUNDSEL
13 SHEPHERDS PURSE
SEE MAY
SHEET

Fig. 11

PLANTS IN FLOWER IN MAY

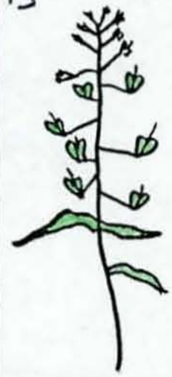
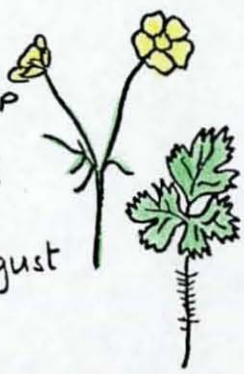
11 SALAD BURNET  Flowers May - August Locations: Limestone Mound & Fen Marsh	12 GROUNDSEL  Flowers: May onwards but can be earlier	13 SHEPHERD'S PURSE  Flowers: May onwarc but can b earlier
14 CREEPING BUTTERCUP  Flowers: May - August	15 COMFREY  Flowers: May - June Location: Fen Marsh	16 WHITE DEADNETT Flowers: May - December 
ALSO IN FLOWER: 1. RED DEADNETTLE 2. COMMON CHICKWEED 3. DAISY 4. DANDELION 5. GROUND IVY 6. COMMON FUMITORY 7. BLACK MEDICK 8. BOG MYRTLE 9. COMMON COTTON GRASS 10. GOLDEN SAXIFRAGE	Early May Only {	IN THE PONDS: MARSH MARIGOLD LADY'S SMOCK GREATER POND SEDG

Fig. 12

considerable amount of cross-referencing and it is always advisable to work outside with the sheet pertaining to that month in conjunction with those which had gone before it.

The pond plants were easier as they were in a specific area of the reserve, thus it was possible to draw an actual distribution chart for them in addition to recording their presence. Fig. 13 shows a typical month.

It was only after the production of these resources that it was fully realised how important material specific to the area could be, and how much use could be gained from it. The author then set about the task of taking the interpretation a stage further from visual keys to actual cataloguing of the species present and the production of information about them.

Plants were photographed, some printed commercially, and others processed in the school darkroom. Each photograph was mounted on card with general information on the plant and its location in the nature reserve. This project took 18 months to complete and covers over 100 species of plants, an example is shown in Fig. 14. In production is a similar (but smaller) volume of the trees of the reserve and school grounds.

To supplement the visual key for pond animals the author produced a booklet entitled "Pond Life - the freshwater animals in the Deeping St. James School Ponds". This covers basic pond ecology (e.g. vegetation zones, food webs) and then specifically illustrates the creatures found in the school ponds. Even with this limitation, it extends over 40 pages, two of which are produced as examples in Figures 15 and 16.

Fifty copies were printed of this for use in the school, however, its usefulness has been acknowledged further afield and copies are to be found in places like the library of the local teachers centre.

The topics for interpretation in this form are endless and work is always 'in progress'. Such resources as these provide children with the chance to work more independently at identifying the flora and fauna around them. They break down the skills of information-getting into manageable steps which is more satisfying and likely to be remembered.

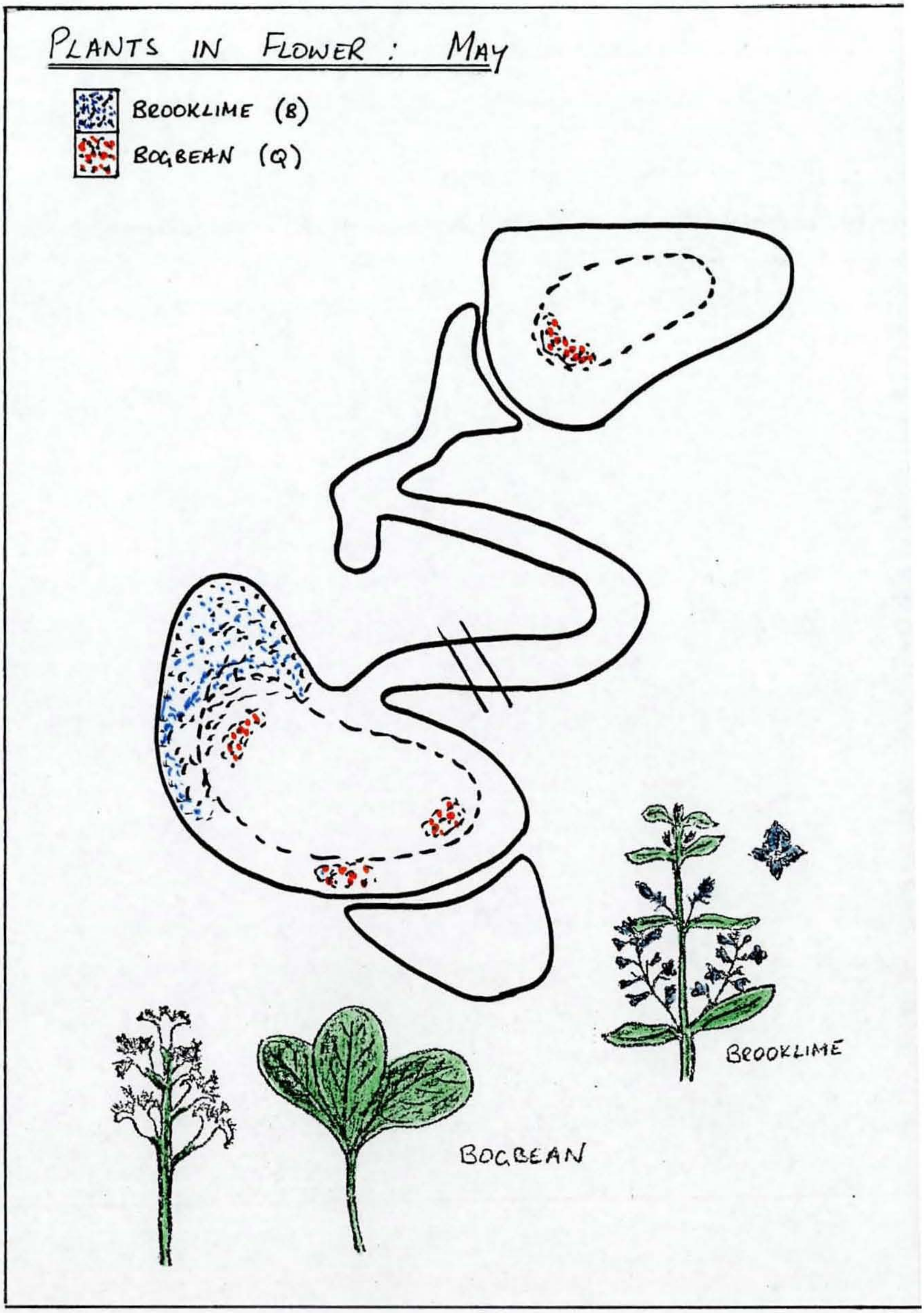

PLANTS IN FLOWER : MAY
BROOKLIME (B)
BOGBEAN (Q)
BROOKLIME
BOGBEAN

Fig. 13

COMMON POPPY
(Papaver rhoeas)

A member of the Poppy family - PAPAVERACEAE.

Annual.

Grows up to 50 cm.

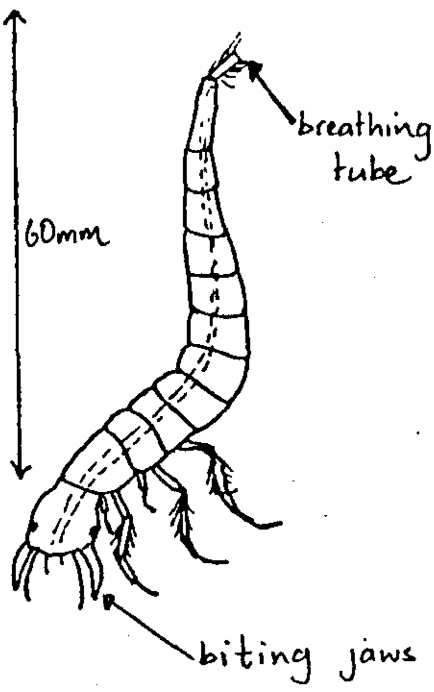
Found on waste places, disturbed ground, fields etc.

Very common.

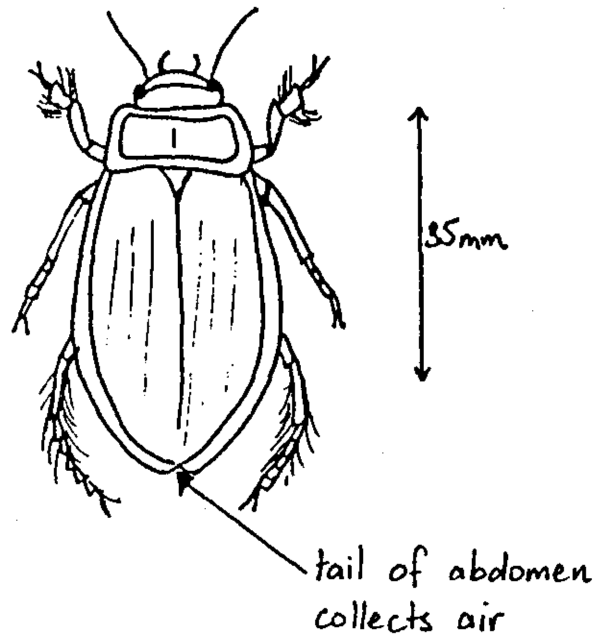
Flowers May to August.

Fig. 14

GREAT DIVING BEETLE



larva



adult

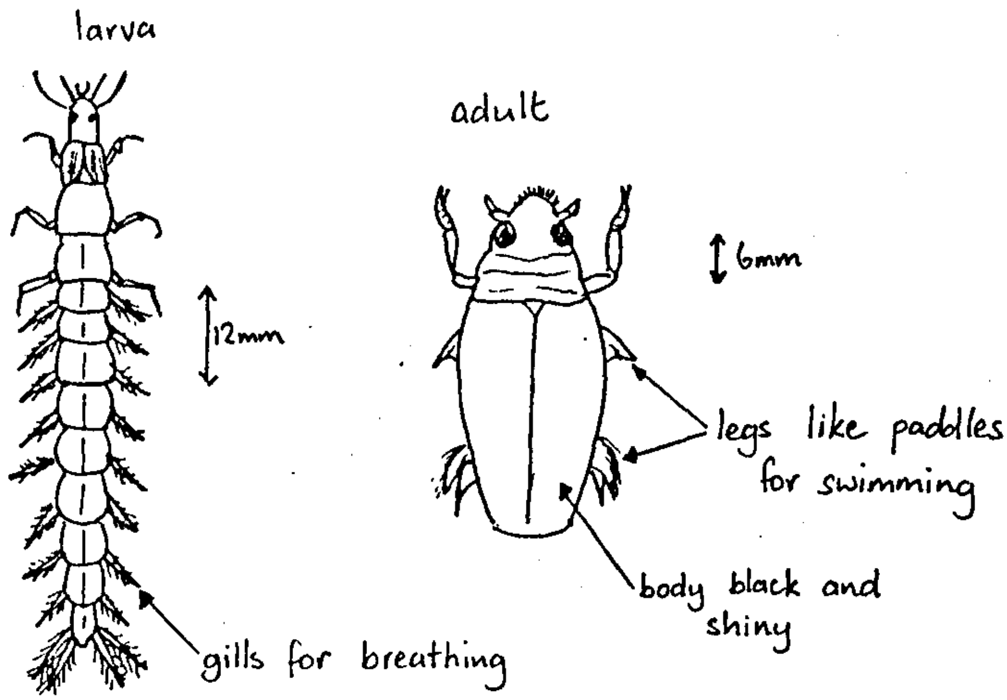
For their size, great diving beetles are probably the most ferocious creatures in the pond. Both the larvae and the adults will attack any other animal, even quite large fish. The larva has two large jaws which it sticks into its prey and sucks out the juices, leaving only the skin. The adult has very strong jaws and chews its prey to pieces. If you hold them in your hands for long, they may try to bite you!

The larva stays in the water for about a year, eating and growing bigger before turning into an adult.

Both larva and adult breathe air and so need to come to the surface from time to time. The larva has a breathing tube at the end of its tail but the adult takes its own bubble of air down with it, trapped under the abdomen.

Fig. 15

WHIRLIGIG BEETLES



Whirligig beetles can be seen mainly in the summer swimming in circles on the water surface. They usually gather together in large groups, supported by the surface film of the water.

They eat insects which have fallen on the water and are drowning, or dead insects just below the surface. To do this they need to be able to see in both air and water, and so, they have special eyes. The eyes are divided into two parts. The top part can see in air, and the bottom part can see in water.

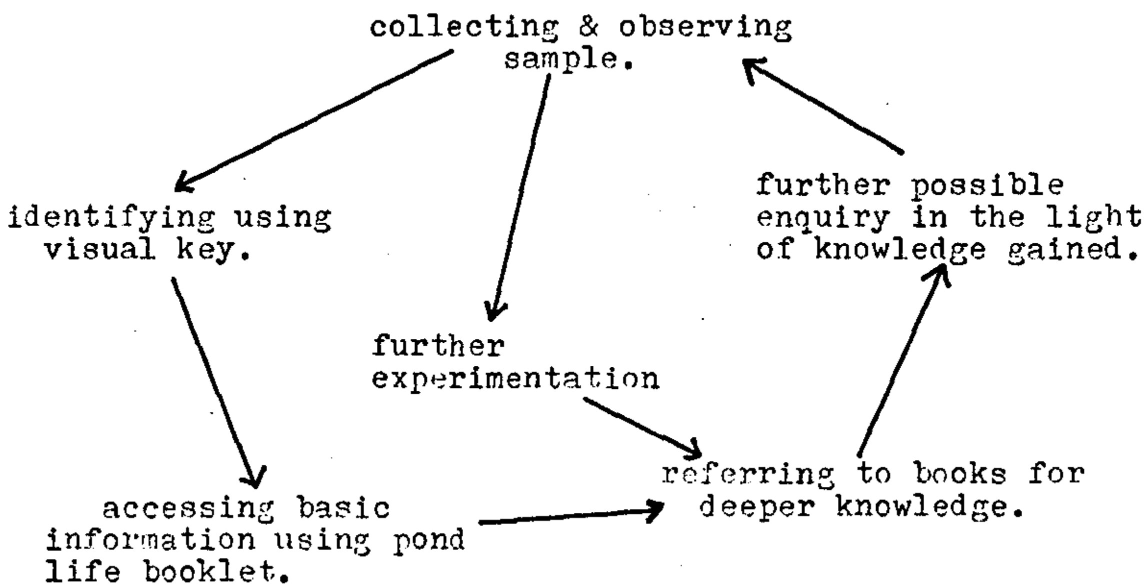
Their two back pairs of legs have become very short, like paddles, and this gives them their very fast, circular swimming pattern.

The larvae have gills and live completely under the water in among the plants. They live on a mixture of dead and dying small insects.

Fig. 16

These resources also make it easier for non-scientific members of staff to constructively use the nature reserve and there is a general concensus that confidence to undertake environmental science work has increased and been made very much easier.

To give an example of how these resources would be used, work on pond animals would probably take the following form:



Another type of resource which has proved very valuable is the work of the children themselves. Their work is often of a high enough standard to be put together in a project booklet and kept as a reference for further work on that subject. For example, there are now records of pond water temperatures, frog sightings and frog-spawn counts for three years and so direct comparisons can be made. There are further studies on plankton, lichen, grasses, fish and many others. The volume of material being compiled is such that there is strong justification for environmental sciences occupying its own section of the library and this may well be one of the considerations of the future.

Other future developments include such ideas as using the school microcomputer for dichotomous keys and for storing a catalogue of available information. The possibilities are increasing continually, all that is required is the time and the energy to carry them out. Both are precious commodities, but already a great deal has been done to give the environmental science curriculum the back-up it needs and deserves.

Evaluation

The evaluation of a project of this nature is difficult. Shipman (1983) has this to say:

> "Evaluating the effectiveness of different curricula has defeated most researchers. Dispute over reliability and validity has been the main outcome, and this has kept academics busy rather than informing teachers of the best way forward."

Despite this pragmatic and pessimistic view, it is true to say that teaching and assessment are inseparable, a fact which can be observed wherever teaching occurs. Much of this is instantaneous, spontaneous and continuous, and a skilled teacher can soon assess the success of a topic by bringing his or her professional judgement to bear on such things as, level of interest, time on task, etc.

In the context of the curriculum, four aspects can be identified to help an attempt at evaluation:

1) Content; the body of knowledge to be studied.
2) Organisation; the relationships between subjects, continuity within them, and the way they are taught.
3) Situation; the situation for which the curriculum has been organised and the way it serves the children.
4) Impact; the effect on pupils, staff, the community, and outside agencies.

The content of the environmental science curriculum has already been discussed in great detail and no more needs to be said here beyond a reminder that the subject matter was chosen not only for its' intrinsic worth, but as a vehicle for skills acquisition and general motivation.

The organisation has been carefully planned to provide opportunities for skills already acquired to be enhanced and new ones introduced. This, almost by definition, produces a strong interweaving of subjects; mathematics, reading, writing, art and communication, all play a part. The effect is further heightened by the school policy of working an integrated day. This complex web requires a variety of teaching strategies involving a combination of child-centred and teacher-centred learning situations.

The situation for which the curriculum has been organised is two fold. Firstly, the opportunity to learn ways of tackling problems by application of the 'scientific method', and secondly, the opportunity to work in the environment with living systems in the hope that attitudes of care and respect for the natural world are fostered.

The overall effectiveness of the content, organisation, and situation of the curriculum, will determine its' impact on staff, pupils and outside agencies. Thus, a consideration of the impact as a whole will give a summative evaluation of the project.

Turning again to Shipman, he recommends that teachers can evaluate impact in three ways:

1) the shared judgements of headteacher and staff.
2) the performance of the pupils.
3) a validation of judgements by eliciting opinions and responses from outside agencies such as inspectors, advisers, neighbouring teachers, parents, and academics.

If constructive usage of an area can be employed as a measurement of success, then Table 2 is adequate proof of the staff members shared judgements of the environmental science area.

Most teachers in the school agree that their own personal knowledge and interest has increased as a result of this work. This is combined with a general concensus of opinion that the children's work is of a high standard, in line with a high level of motivation and interest. It is in qualifying this last statement that problems arise. The objective assessment of pupil performance has been the subject of many erudite books and papers but the production of practical classroom models remains elusive.

Standardised tests exist in such subjects as mathematics and reading, the results of which can be compared with objective criteria but in most areas of the primary curriculum such a quantitative approach is most difficult.

In a qualitative approach it is possible to pass pro-

Table 2

The Evolution of the Environmental Science Curriculum.

Time Scale	Curriculum Design	Policy and Usage: % of class time spent	Policy and Usage: Structure of work
Before project started	No general policy	0.5%	taken as it arose
Year 1	Educational aims & objectives defined ↓ discussion & planning ↓ initial trial topics taught by author ↓	5-10%	a small, but separate part of the curriculum
Year 2	development of these topics into curriculum guidelines ↓	5-10%	still taught as a separate subject
Year 3 to present	introduction and consolidation of curriculum throughout school	10-20%	work forms a much larger part of the curriculum integrated with other class activities

fessional judgement using such parameters as interest, motivation (time on task), and standard of work produced. There are examples of the latter in earlier parts of the case study. These examples are representative of the range and overall quality of the children's work in environmental science and, as illustrations to the narrative, represent work by children across the ability range.

The interest and motivation shown by the children is indisputable. Many examples could be cited of children of all levels of ability lavishing an unparalleled amount of time and care on a project or investigation. This enthusiasm spreads beyond the bounds of school lesson time. Participation in clubs and other extramural activities is very high; both the school 'gardening' club and the 'Watch' group are heavily oversubscribed, and weekends are gladly spent nature rambling, birdwatching, pond-clearing, or some other related activity. Many of the children have become individual members of such national clubs as the Young Ornithologists, and some work at home on projects in their own time. The author is often shown these and is always impressed by the amount of time, effort, and dedication which has gone into them. Some have been submitted for competitions and have won prizes, or been highly commended.

A consideration of these examples suggests that pupil performance is not only high, but has increased since the introduction of the environmental science scheme. An important task for the future is to produce a checklist of desired skills, knowledge, and concepts, and attempt a more quantitative criterion-referenced evaluation. Such a scheme will need a great deal of thought, discussion, and co-operation.

Returning to the present, the third of Shipman's methods for evaluating impact can now be applied.

The headteacher and staff are convinced of the importance of the environmental science scheme but their professional judgements are best validated by gaining the opinions of outside agencies.

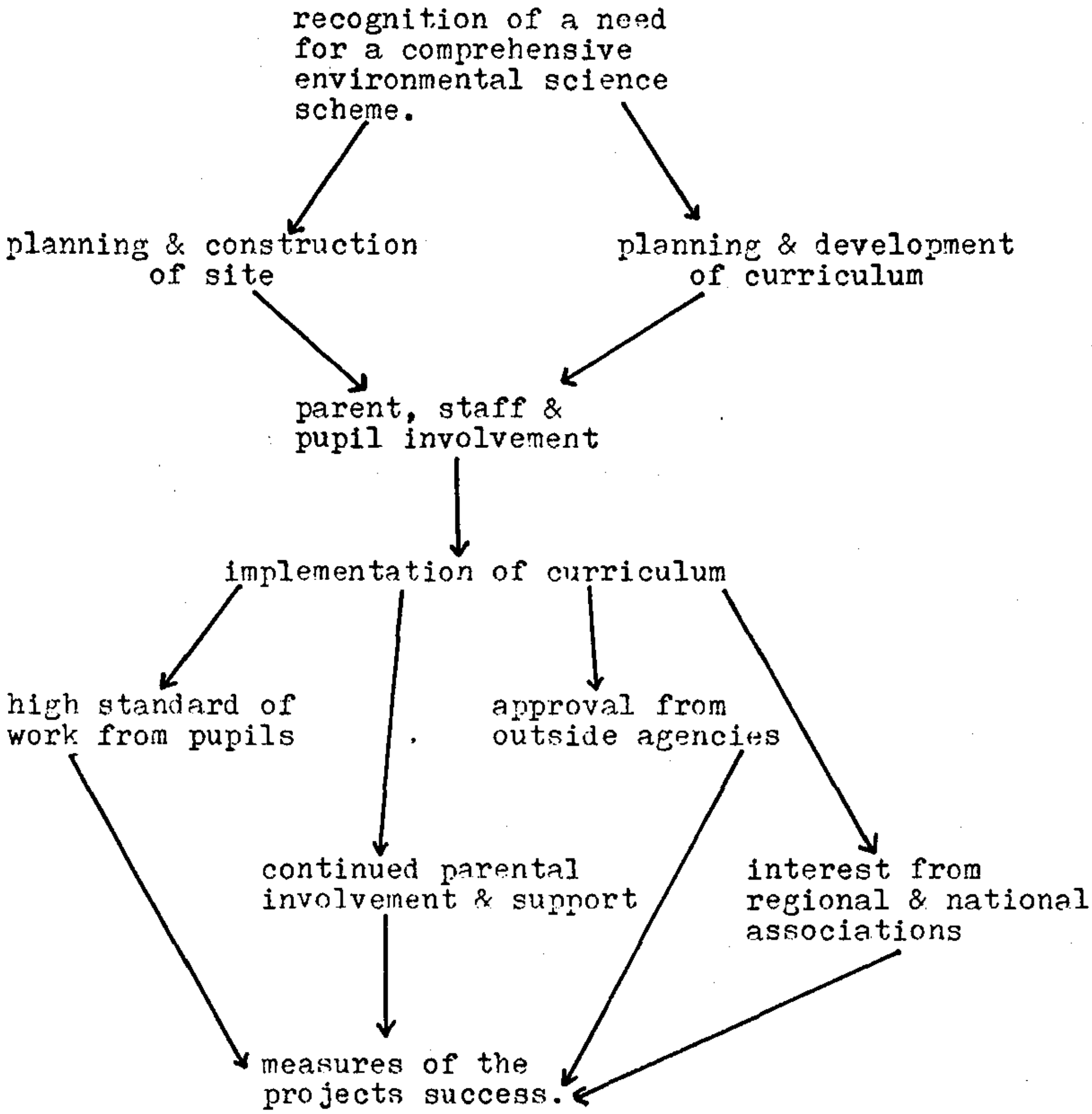
The closest of these are the parents and community around the school. From the very start of the project parental involvement was high, indeed, it couldn't have started without the massive support received. People such as firms and local contractors, unconnected directly with the school, also gave freely of their skills and knowledge because of a belief in the benefits of such a project. What started as a working group of parents to construct the actual habitats has widened to include habitat management, small group supervision, cataloguing resources, and photographic recording. They give the school a tremendous amount of support and are very interested in their children's work, so much so, that the author has often been approached by them to run a course incorporating the type of work done by their children! This is something to which serious consideration must be given.

The inspectorate and advisory service have paid very close attention to the development of the project and cite the school as an excellent example of good practise in environmental education. There are numerous visits throughout the year from advisers, inspectors, headteachers, teachers, and lecturers, wanting to know more about the scheme of work and its' operation. On occasions, when a visit to the school has not been feasible, the author has been asked to go to other schools, colleges, and universities to lecture and advise.

The school is repeatedly asked to put on exhibitions of childrens' work. These have covered such diverse locations as The East of England Show and a conference of Surrey teachers and advisers. There have been occasions when, due to time and other commitments, invitations and requests to exhibit have had to be declined.

Perhaps the final accolade is when the work of the school is recognised nationally. This has happened when children have been successful with their projects in competitions. An example of their work has also been published in the Association for Science Education's broadsheet 'Primary Science'. Both the B.B.C. and I.T.V. have filmed the children at work for local programmes, and the school has won a 'Kestrel Award! This is an award organised by B.B.C.'s 'Wildtrack' programme for work in the promotion

Table 3


recognition of a need for a comprehensive environmental science scheme.
planning & construction of site
planning & development of curriculum
parent, staff & pupil involvement
implementation of curriculum
high standard of work from pupils
approval from outside agencies
continued parental involvement & support
interest from regional & national associations
measures of the projects success.

of conservation.

The start of this project can be likened to someone dropping a large stone in a still pool; the ripples have spread far and wide in ever-increasing circles.

Table 3 summarises the situation:

Although this evaluation is of a qualitative nature, a number of indisputable facts emerge concerning the schools approach to environmental science:

1) that involvement in the subject has increased at all levels from staff, pupils, and parents,
2) that, through this involvement, levels of interest and amount of time engaged in environmental activities has increased by all concerned,
3) that the increased interest and commitment by the pupils has produced a standard of work which has been recognised nationally as very high,
4) that the work done at school is used by other educators as an example of good scientific and educational practice.

The author feels, therefore, that the time, effort, expertise, and enthusiasm which has gone into the project is more than justified. The school has a resource which is second to none and a method of working which gives children the opportunity to think and work scientifically which, regardless of whether science subjects are studied, gives an approach to problem-solving which can be applied to all areas of the curriculum, and beyond. In the words of the Warnock Report (1978), the aim of the curriculum should be:

"firstly, to enlarge a child's knowledge, experience and imaginative understanding, and thus his awareness of moral values and capacity for enjoyment: and secondly, to enable him to enter the world after formal education is over as an active participant in society and a responsible contributor to it."

* * * *

Having established that properly structured science work in primary schools can have very desirable results, both educationally and socially, the author decided it would be important and appropriate to establish the presence and status of similar work in other primary schools in Lincolnshire.

The impression gained during advisory visits and discussions with other teachers was that environmental work was viewed as important but problems revolved around an inability, through insufficient expertise, to draw together ideas into a cohesive scheme. There was a feeling that the sound, practical advice which was so desperately needed, was not easily available.

Despite this, some schools were engaged in interesting and promising work and so it seemed timely to run a survey to gain some insight into provision, resources, and curriculum organisation for environmental science.

The next chapter traces the development and implementation of a survey by questionnaire, and discusses the implications which the results produced.

CHAPTER 3

A survey of Environmental Science teaching and provision in Lincolnshire primary schools

SURVEY REPORT

1) Introduction

A questionnaire survey was deemed most appropriate as the time and finance involved in actual visits to schools were prohibitive. A careful investigation of questionnaire design was conducted and a literature survey revealed that in 1974 the University of Nottingham A.T.O. In-service Science Committee carried out a survey, by questionnaire, into science education provision and I.N.S.E.T. requirements in primary schools in Nottinghamshire, Derbyshire, and Lincolnshire. The chairman of the committee was H.W. Bradley, who interpreted the results from the survey and produced a report.

The survey found that very few schools had science specialists in them and science played a very small role in the work of primary schools.

The majority of teachers questioned had done no I.N.S.E.T. work but a number expressed a wish to have help with classroom activities associated with: skills improvement, problem-solving, improving personal knowledge, and curriculum development.

There was an added desire for in-service work to be done in school time.

In his conclusion Bradley highlighted two aspects of the data which, if acted upon, might improve the situation. Firstly, that more science seemed to be done in schools with a science specialist and secondly, an obvious need was expressed[10] for activities outside the school which expanded knowledge and inspired confidence in teachers to undertake science work with their classes.

The final paragraph of his conclusion states,

"Perhaps the brightest hope for the future lies in linking these two together, the in-school organisation and the outside school support, much more closely than in the past, so that involvement in one encourages involvement in the other and all teachers in a staff become involved."

This report provided a starting point for the present survey which evolved into a two-fold study; firstly, an assessment of the present situation in environmental science in primary schools in Lincolnshire, and secondly, a comparison of results with the Bradley Report to observe and assess any changes which may have taken place in the last decade.

The final questionnaire took two forms and incorporated some of the questions asked by Bradley in 1974. There was one questionnaire for headteachers to complete involving questions on school size, organisation, and facilities; and another for teachers requesting information concerning classroom organisation, attitudes, and training.

The questions themselves also took two forms. Most were of a yes/no response and required the appropriate box to be ticked, but questions which needed a degree of response were designed so that the respondent circled a number along a continuum of 1 to 6 as a measure of agreement or importance. A continuum of six responses was preferred as five or seven response alternatives would have produced a mid-point which would provide a safe haven for respondents reluctant to commit themselves.

Copies of the actual questionnaires used my be found in Appendix III.

2) The Sample.

Due to time and cost logistics it was decided to limit the sample to primary schools in Lincolnshire. The schools within that county were first separated into groups, according to the number of pupils on roll. This produced the following pattern:

Size of school	Number	Percentage of Total
Group 1 (>50)	85	25%
Group 2 (51-100)	77	23%
Group 3 (101-200)	90	27%
Group 4 (201-400)	70	21%
Group 5 (401+)	10	4%
Total	332	

As Lincolnshire is a predominantly rural county, there is a high proportion of small village schools. This is reflected in the fact that 48% of schools have less than 100 pupils on roll. The author felt it was necessary to preserve these proportions when choosing the sample in order to obtain an accurate representation of the school structure within the county. Total sample numbers for each group were fixed but within that, the schools were selected randomly.

In all, 80 schools were chosen and, in order to maximise the questionnaire returns, each headteacher was contacted by telephone, had the survey explained to him/her, and asked if the school would take part. All agreed to do so.

A pilot sample to 30 schools was despatched in November, 1983 and, as the returns on these showed no apparent problems with the questionnaire format, it was then circulated to the remaining 50 schools in March 1984. The total returns were as follows:

Size of school		No. sent	No. returned
Group:	1	20 (25%)	9 (16%)
	2	18 (22%)	17 (30%)
	3	21 (26%)	10 (18%)
	4	17 (21%)	16 (29%)
	5	5 (6%)	4 (7%)
	Total	80	56

The returns represented 70% of the total sample. Whilst this is acceptable, the author had hoped for a higher response in view of the fact that all the schools had agreed to participate.

Along with the replies from the 56 headteachers were 269 teacher returns, giving a large enough sample to analyse for trends and differences.

The bulk of the analysis was to be done using a computer statistics programme called 'Minitab' and the items on the questionnaires had been constructed with that in mind.

3) Analysis of Results

The analysis was done with the completed headteachers' and teachers' results as two separate sets. Percentage responses were found and, on the questions requiring a score from 1 to 6, standard deviations and means were also calculated.

From these two basic sets of data it was possible to remove and compare subsets to see which factors, if any, were affecting the overall results. The following subsets were examined:

a) Headteachers' Questionnaire:
   size of school.
   the effect of a science specialist on the staff.
   the effect of the possession of a school site for environmental sciences.

b) Teachers' Questionnaire:
   differences in response between men and women.
   differences in response between infant and junior teachers.
   the length of teaching experience.
   the responses of the specialist and non-specialist science teachers.

Three statistical tests were then applied to the pairs of subsets:

1) Percentage scores were compared using a difference of proportion test.
2) Means were compared using the t-test for uncorrelated data.
3) The Spearman rank correlation coefficient was used to compare rankings of importance of skills and goals.

The details of these tests can be found in Appendix IV.

Problems emerged when taking subsets from the headteacher questionnaire because of the sample size. This meant that only very large differences in proportions would show as statistically significant, in some cases as much as 15 to 20 points. There were, however, a number of differences which, although not large enough to be significant, were worthy of consideration. The author has referred to these as 'trends' and has indicated them in the text as well as results which were significant at the 5% level or more.

A further anomaly occurred on the teacher questionnaire. An analysis of the differences in response between men and women teachers showed that men thought the skills and goals of environmental science were significantly more important. Likewise, there appeared to be a similar difference between infant and junior teachers. This then posed the problem as to which factor was affecting the results, sex or age group taught?

Further analysis showed that all the men (except 1) taught junior age children so, if the response differences were sex-linked, these answers could be biasing the results of the infant/junior comparison. The tests were re-run with the men's responses removed and the following comparisons were made:

a) infant women / junior women.

b) junior women / junior men.

The junior women rated skills and goals significantly higher than infant women but there was no significant difference between junior women and junior men.

It follows therefore that the measured differences were due to the age of the children taught and not directly sex-linked.

4) The Results

a) The Schools.

The responses of schools within the different groups varied, thus altering the original proportions. This factor, in conjunction with sample size, made a re-grouping necessary. The sample was therefore separated into two groups; schools with 100 pupils or less were classed as small schools whereas more than 100 pupils earned the designation of large school.

Size of School	No.		
Group: 1	9)	small schools	= 26 = 46%
2	17)		
3	10)	large schools	= 30 = 54%
4	16)		
5	4)		

Most of the schools sampled covered the whole primary age range of 5-11 years, but other combinations were present:

Age range of pupils:	No.	% response
5-7	3	5
8-11	4	7
5-11	43	77
Other	6	11

None of the schools were entirely open-plan, but 12% had some open-plan areas. The greater majority, 88%, had a classroom for each class.

All schools said they did environmental science in some form, the commonest policy being to treat it as a planned part of broader topics. A number of schools, however, admitted that they had no general policy.

Environmental science takes place as:	No.	% response
1) a separate part of the curriculum	5	9
2) a planned part of broader topics	25	45
3) it arises	9	16
4) not at all	0	0
5) no general policy	3	5
6) some combination of the above	16	25

The pattern was repeated for both large and small schools with a trend (7% against 12%) for large schools to treat environmental science as a separate part of the curriculum. This may be linked to the trend for science specialists to be in the larger schools although only 19 out of the 56 schools (34%) had a science specialist anyway.

No. of science specialists:	No.	%
None	37	66
1	14	25
2	4	7
3	1	2

There is a suggestion, that the presence of a science specialist may affect school policy as more schools with a science specialist treat environmental science as a separate part of the curriculum. This is reinforced by the fact that where a post of responsibility for science exists, it is filled by a science specialist, where available.

School Policy for environmental science	% response science specialist	% response non-specialist
1) a separate part of the curriculum	16	6
2) a planned part of broader topics	31	53
3) as it arises	11	19

4)	not done	0	0
5)	no general policy	11	3
6)	some combination of the above	31	19

b) School Grounds as environmental Science Areas.

20 out of the 56 schools (36%) had a school site with facilities for environmental science work; 35% of these were small schools and 37% large schools. The possession of such a site, therefore, was not linked to school size.

60% of these sites had been built after the school, presumably as a response to a recognised need. They were mostly financed by fund-raising efforts and grants and were built by voluntary labour.

The six most common habitats available for study on these sites were as follows:

Bird table/nest boxes	75%
grassland	60%
ponds	55%
wood (or area of trees)	50%
chequerboard garden	40%
garden area	40%

Other habitats present were a tree nursery (30%), marshy area (25%), and moving water (10%). One school also kept livestock in the form of bantams, chickens and ducks.

All the schools said they used sites away from the school grounds. The most popular were local habitats (77%), farm visits (57%), and zoo/wildlife park visits (50%).

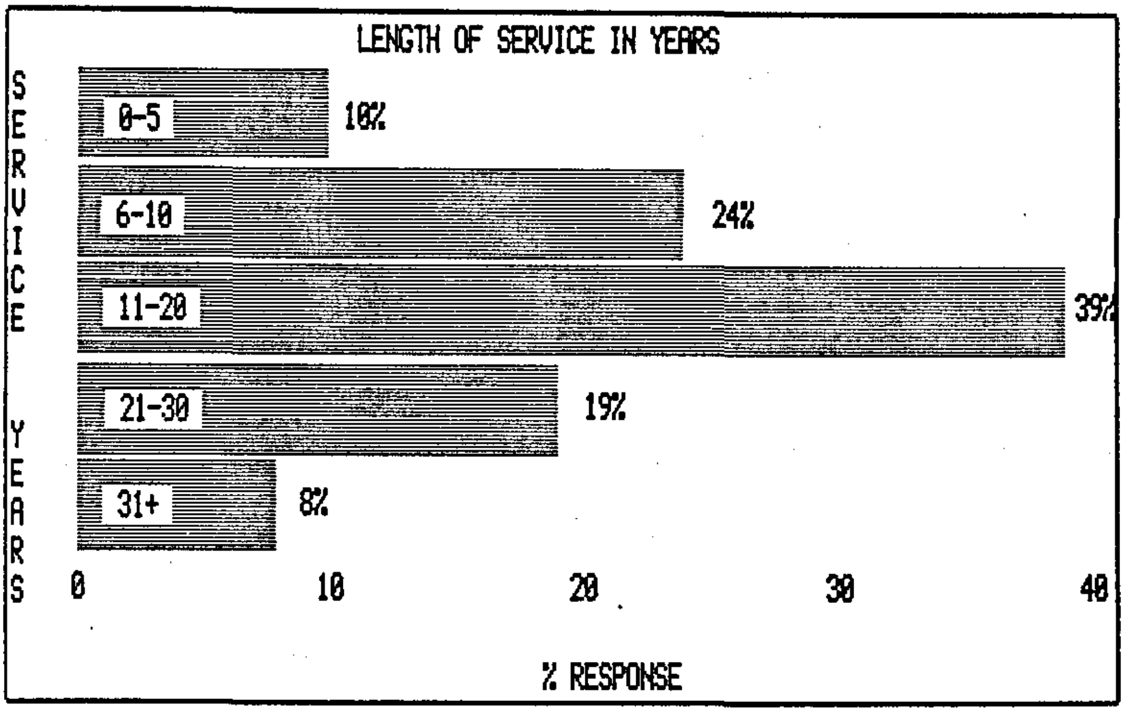
Schools without their own sites tended to use some facilities more, notably, nature reserves, field study centres, wildfowl centres, and gardens/parks.

The data from which these results were obtained can be found in Appendix V. (pages 148 - 158)

c) The Teachers

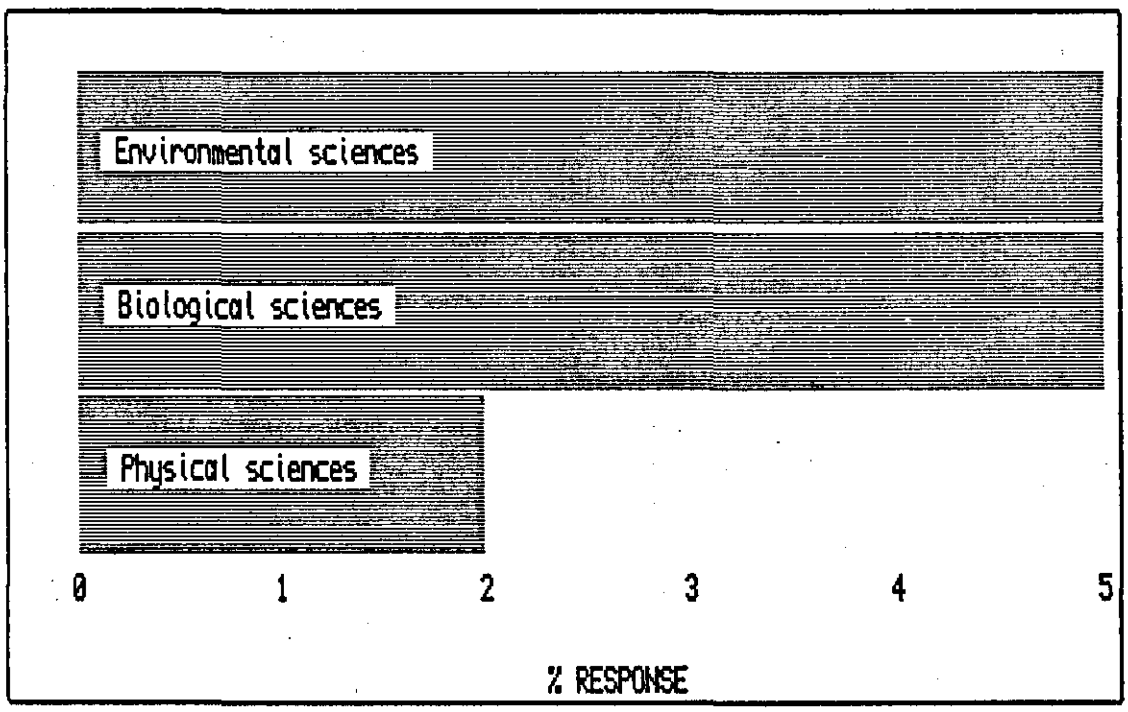
The sample of teachers consisted of 74 (28%) men and 188 (72%) women. 95 (38%) of these were infant teachers and 153 (62%) taught juniors.

10% of the teachers were in their first five years of teaching and 8% had taught for more than 31 years. The majority, however, had taught for between 11 and 20 years.



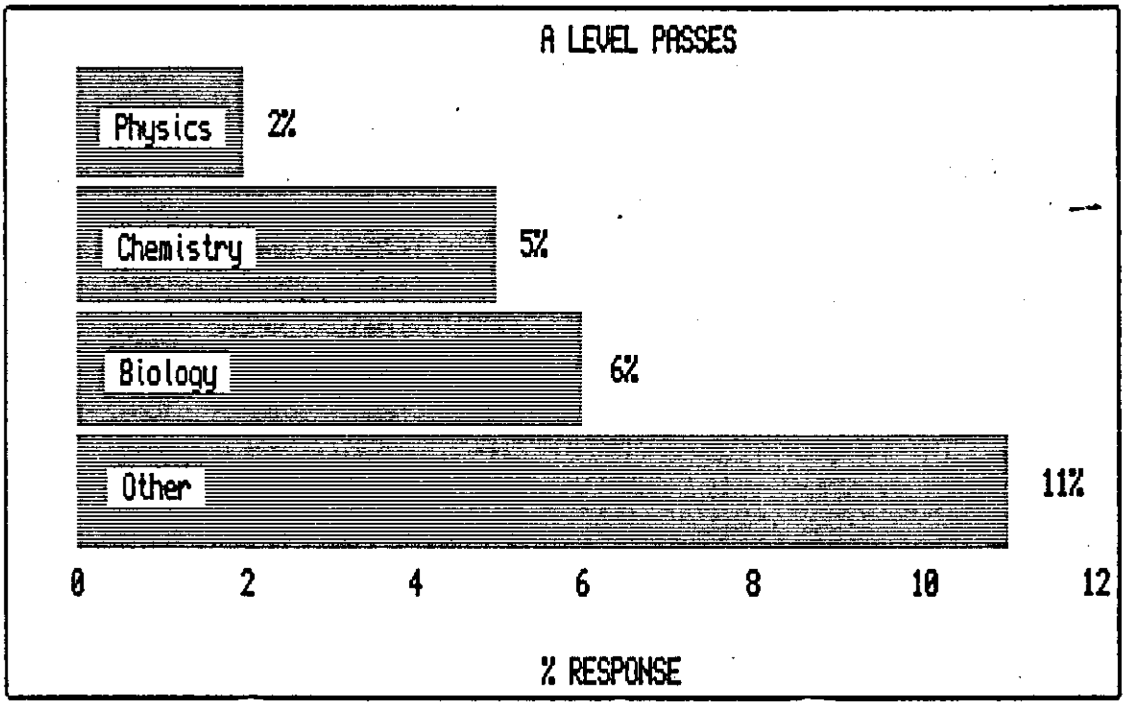
26% of teachers are graduates but only 3% of their degrees are in a science subject (i.e. 9 teachers out of a total of 269).

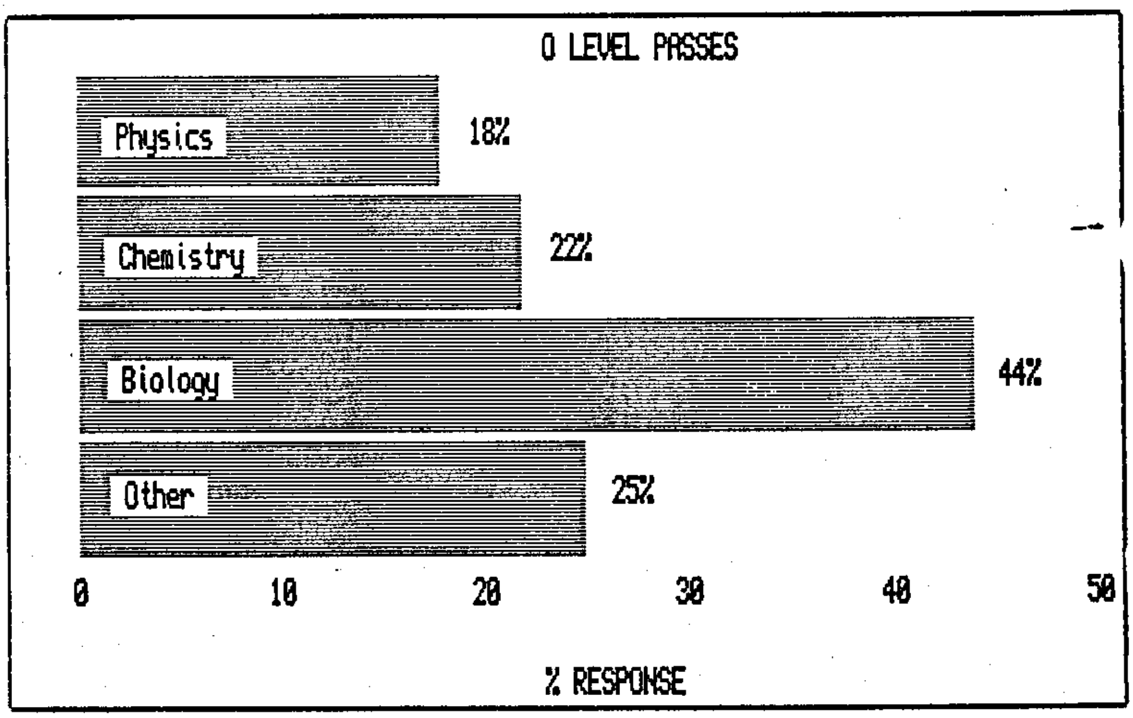
A further 12% took science as a main subject at Certificate of Education level, the majority of which were biological/environmental science courses.



38% of teachers had received no training in science.

The pattern is similar for 'O' and 'A' level study with the exception of biology which was studied to 'O' level by 44% of the teachers.





When questioned about in-service education 57% of the sample showed some involvement in a science-based course during their teaching career. Of that number, 50% had not been involved in I.N.S.E.T. training since 1st September 1980, 42% had done less than a week with only 8% experiencing courses of one week or longer.

Such a result may reflect the fact that teachers find courses unhelpful, this was actually mentioned in one case. Alternatively, it may be the case that there are not enough courses to attend, a possibility mentioned on several occasions by teachers, in conjunction with the fact that financial assistance was difficult to obtain.

The latter suggestion is reinforced by the responses to question 10 concerning the provision of back-up resourses from the L.E.A.

On the scale of 1-6 importance, the midpoint would be 3.5. All of the mean scores are in excess of this, suggesting that teachers considered all of the provisions listed important. Within that premise, some were more important than others and may be ranked as follows:

		mean score
1)	more financial assistance	4.6
2)	prepared guidelines in curriculum content	4.25
3)	more courses to attend	4.22
4)	a greater availability of the advisory service	4.13
5)	prepared guidelines for equipment buying	3.96
6)	a course based at your school	3.8

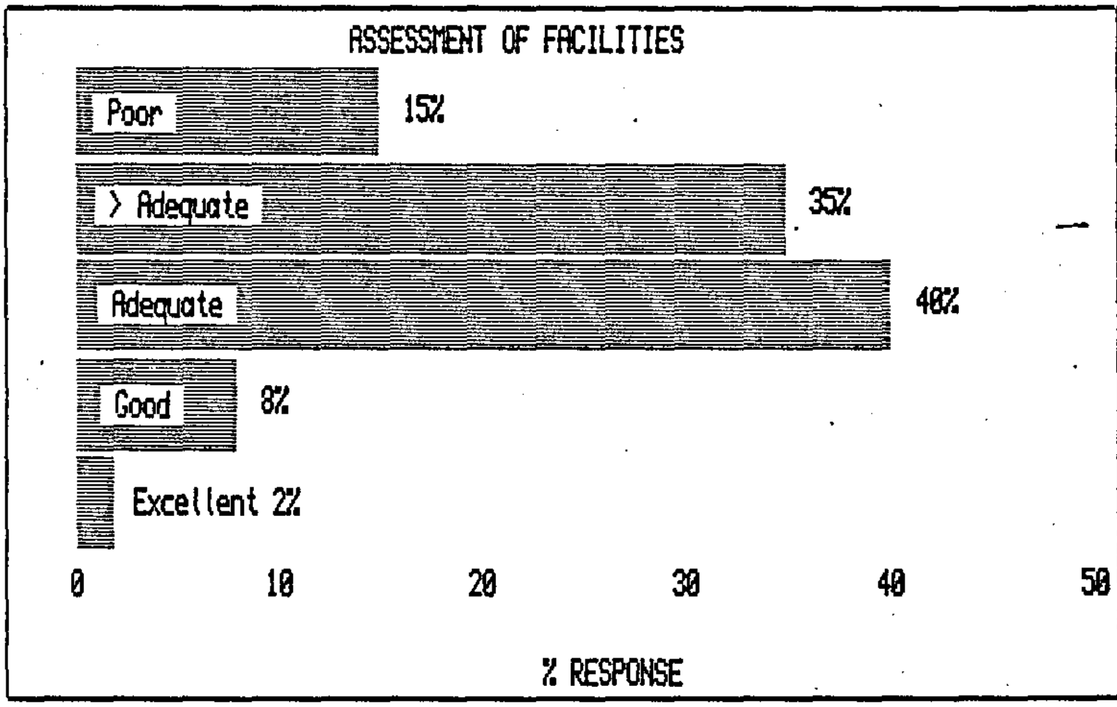
d) Teachers involvement with environmental studies and their attitudes to it.

Environmental science was taught in some form by all teachers. 50% described their work as either a specified part of the curriculum, as a planned part of broader topics, or a combination of the two. 66% also said a scheme of work or set of broad guidelines was available.

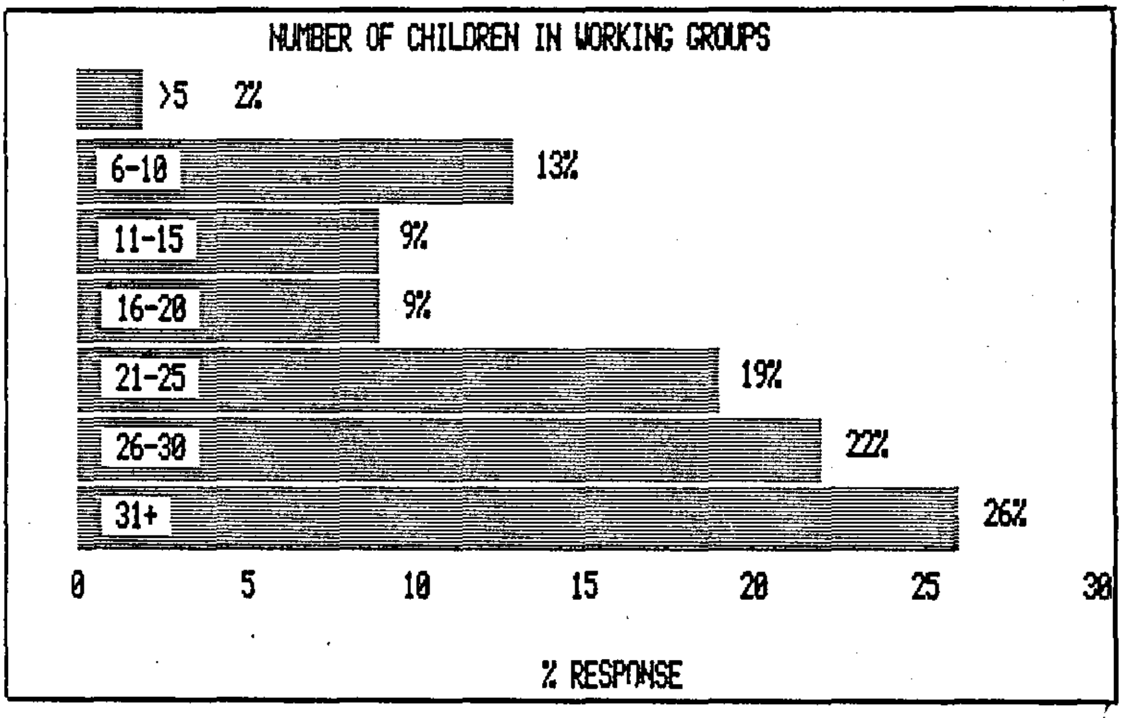
Environmental science developed as it arose for 50% of teachers, and a further 34% admitted to no general policy.

Some teachers commented that it was very difficult to judge the amount of time spent on environmental activities (particularly in an integrated day situation), however, 52% estimated they spent 5% of their time, 34% used 10% of lesson time, and a further 14% judged their time for environmental science as 15% or more.

40% of teachers described their available first hand facilities as adequate whereas 50% felt they were poor, or less than adequate. Only 10% considered them good or excellent.



The size of group undertaking environmental science at one time varied considerably. Some teachers managed to do small group work within a class but most worked as a class unit. The need for an opportunity to do small group work more often was recognised in part 7 of question 10. When asked to state what other L.E.A. services would be important, many teachers requested more staff and/or ancillary help.



The two major attempts to introduce a national science scheme into primary schools were Nuffield Primary Science and the Schools Council project Science 5/13. Teachers were asked to rate their usage and/or knowledge of these schemes on a 1-6 scale. Scoring 1 would mean the teacher had not heard of the scheme and scoring 6 would mean it was used on a regular basis. Scores of 2-5 would indicate a lesser or greater degree of knowledge and usage.

Nuffield Science scored rather low with 10% of teachers not having heard of it and a further 59% who had heard of it but did not use it with any regularity. Only 4% of teachers said the scheme was used regularly.

Science 5/13 fared a little better as 10% of teachers used it regularly, with a further 40% using it occasionally. Even so, 38% rarely used it and 12% had not heard of it.

T.V. programmes were only used a moderate amount (mean 3.16). This may be a reflection of the material available but some schools pointed out that they did not have a television to watch.

Teachers were next asked to express their opinions on the skills and goals of environmental science and to rate their importance. As before, they used a scale from

1-6; 1 indicating not important, 6 indicating essential. Again taking the mid-point to be 3.5, almost all the mean scores were above this. That is to say, all of the items listed were considered important but can be ranked according to order of importance.

Skills:	Mean score
1) Make careful, first hand observations	5.82
2) Make drawings from first hand observations	4.84
3) Use reference books for further information	4.77
4) Draw conclusions from results or make generalisations based on observations	4.73
5) Write from first hand observations	4.58
6) Make notes of observations/results during the course of their work.	4.17
7) Make a satisfactory record of work	4.13
8) Follow carefully instructions from a workcard, book or blackboard.	4.10
9) Identify the variables operating in certain situations	3.69
10) Design own experiments/investigations	3.49
11) Choose what kind of record to make of their work.	3.31
12) Decide the aspect of the topic they wish to study/investigate	3.29

The making and use of observations were clearly considered the most important whereas the activities in which children made decisions on their own work were thought to be the least important.

Teachers were very consistent in their responses to goals in environmental science and there was an almost unanimous decision that a knowledge, understanding and respect of the natural world was very important indeed.

Goals:	Mean score
1) A respect and appreciation of the natural world.	5.66
2) The ability to observe carefully.	5.61
3) A knowledge of the natural world around us.	5.55
4) The enjoyment of environmental activities.	5.53
5) A questioning attitude towards surroundings.	5.48

6) An understanding of basic concepts such as habitat differences, living requirements etc. 5.06
7) The ability to use basic equipment safely and accurately. 4.96
8) The ability to carry out simple investigations carefully and safely. 4.79
9) The development of creative skills such as art, descriptive and imaginative writing etc. 4.75
10) The ability to find information from reference books. 4.61
11) Problem solving skills. 4.38

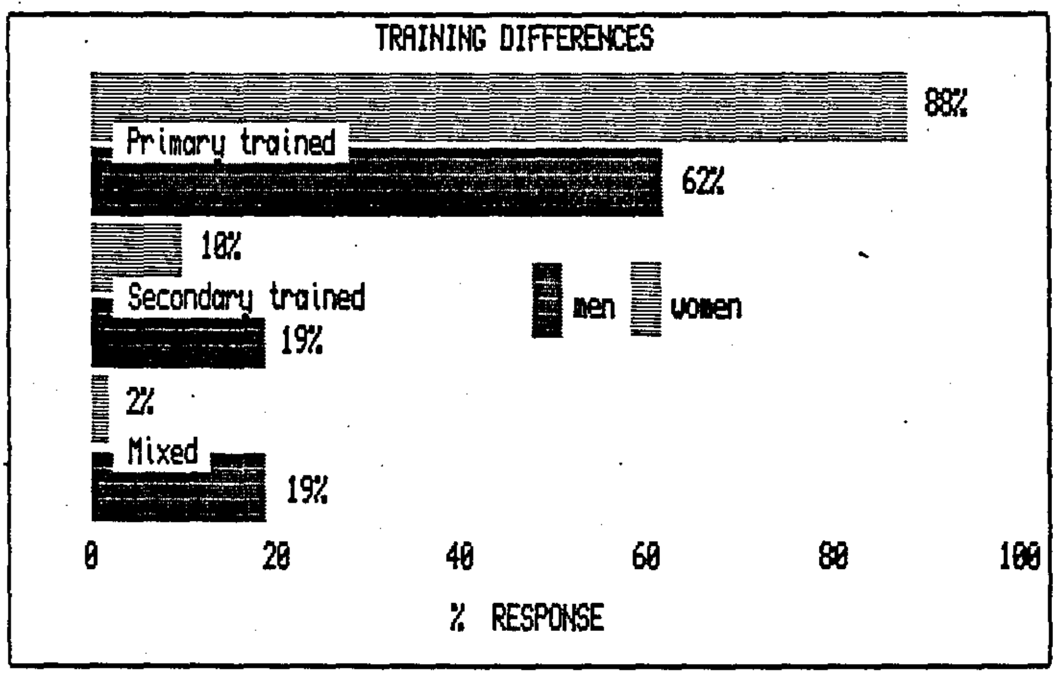
Further details of this data can be found in Appendix V(pages 159 - 163)

e) <u>Differences in response from men and women teachers.</u>

The most obvious, and significant (p=.01), difference between men and women teachers was in the training they had received.

Degrees were more common among men than women (39% of men against 20% of women) but there was no difference in the following of science courses as a main subject among non-graduates, (each scored 12%).

The two main differences were in a total lack of training in science, and the age level for which teachers were trained. 24% of men had received no science training as compared with 44% of women. Only 62% of men were specifically primary trained in comparison with 88% women.



The analysis of the in-service training data showed that significantly more men than women (p=.01) had participated in a science-based course during their career (66% against 53%) but there were no significant differences between the lengths of time spent on courses.

(Data ref: Appendix V pages 164 - 167)

f) <u>Differences in response due to the age-group taught</u>.

Within the sample of teachers, 95 (38%) taught the infant age group (5-7 year olds), whilst 153 (62%) taught children of junior age (8-11 years).

Infant teachers tended to develop environmental science 'as it arose' more often than junior teachers (59% as against 44%). They also tended to work in smaller groups:

size of group.	Infants %	Juniors %
Less than 5	8	3
6-10	16	11
11-15	7	12
16-20	14	8
21-25	27	12
26-30	18	24
31+	12	33

The highest percentage of infant responses were in the 21-25 group size in comparison to the 31+ group for juniors.

These results are not unexpected as infant classes tend to be smaller, and the organisation of an infant classroom is often more integrated with environmental science forming part of general topic work.

Infant teachers make significantly less use of T.V. programmes (p=.01) than juniors, but this may simply reflect a lack of suitable material for this age group.

The ranking of skills and goals was very similar between infants and juniors but infants, in general, rated them as significantly less important. A number of teachers said that some of the skills were not really applicable to infant children as, at that age, they were so limited in their abilities.

(Data ref: Appendix V pages 168 - 170)

g) Differences in response due to training.

When the responses between teachers with some degree of specialism in science (defined as main subject or degree level) were compared with teachers with no formal training, several significant differences emerged.

Environmental science was much more likely to be taught as a separate part of the curriculum in classes with a science specialist (48% as against 25%). The Science 5/13 scheme is also more likely to be used, as are T.V. programmes.

There is also a trend which suggests the percentage of total lesson time spent on environmental science activities tends to be greater with a science specialist; 60% of science specialists said they spent 10% or more lesson time compared with 48% of non-specialists.

Interesting and significant (p=.01) differences also emerge when looking at the skills and goals of environmental science. Although the rank order remains unchanged, science specialists rated the following as more important:

	Mean Score Specialists	Mean Score Non-specialists
The ability to design own experiments/investigations	4.17	3.43
The ability to identify variables operating in certain situations	4.35	3.56

This is not too surprising as these could certainly be regarded as science-specific activities and are therefore likely to be appreciated as more important by scientists.

There was also a significant difference in the importance of the use of reference books for further information, but this time it was the non-specialists who felt this ability was more important. This may be because science specialists, whilst acknowledging the importance of reference books, may prefer to concentrate on the practical side of the subject, particularly in the initial stages.

(Data ref: Appendix V pages 171 - 173)

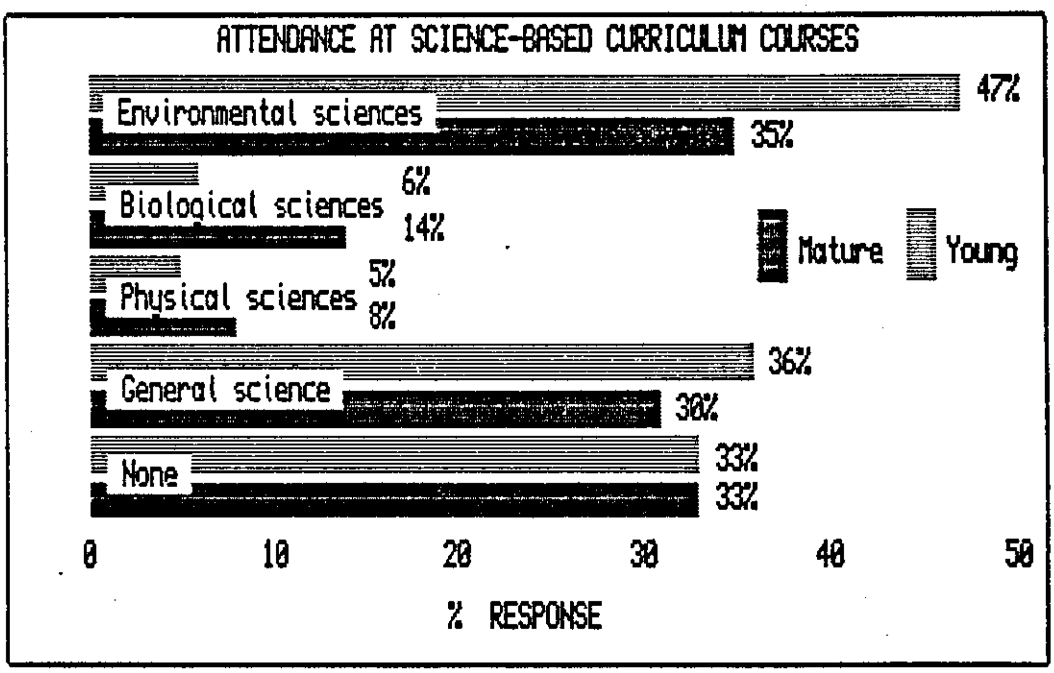
h) Differences in response due to length of service.

Ten years teaching experience was taken as the dividing line between 'young' and 'mature' teachers. Thus, there were 88 (34%) 'young' teachers and 173 (66%) 'mature' teachers in the samples.

There were significant differences in training between the two samples. 36% of 'young' teachers held degrees compared with 19% of 'mature' teachers. This probably reflects the changes in training policy and the introduction of the B.Ed. degree.

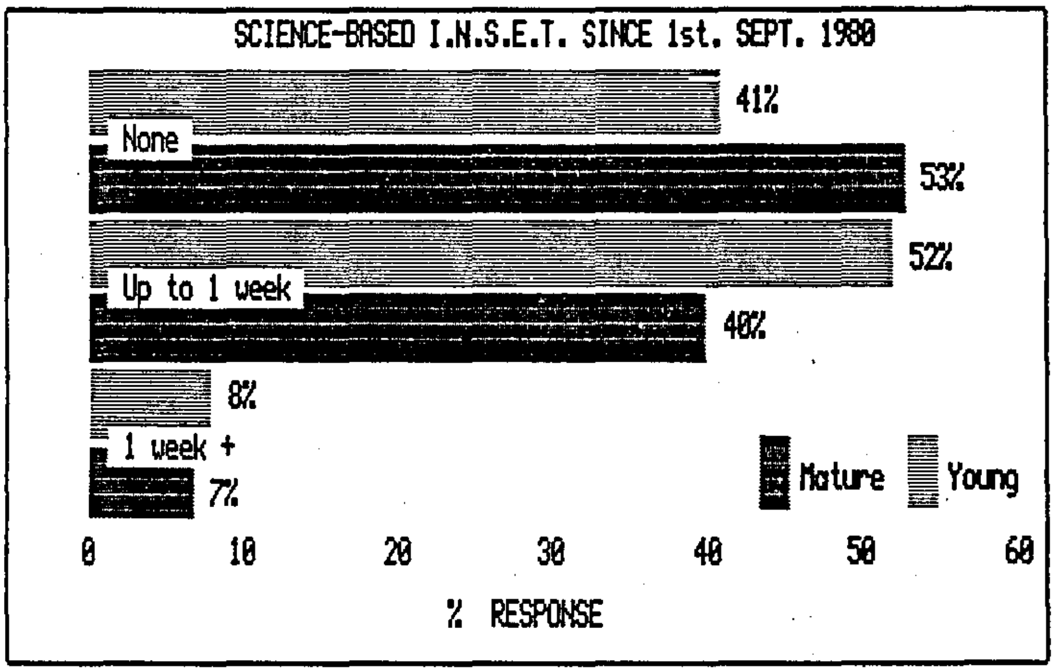
A higher proportion of 'mature' teachers are untrained in science at further education level, 43% as against 28% 'young' teachers.

In curriculum courses more 'young' teachers attended environmental science courses, but more 'mature' teachers have attended biological science courses. This, again, is probably a reflection of the fact that courses with an environmental bias are a comparatively recent addition to the training options for teachers.



At 'O' and 'A' level standards the differences seem to be in the physical sciences with chemistry and physics scoring significantly higher (p=.01) among 'mature' teachers.

65% of 'mature' teachers had attended some science-based course during their teaching careers, against 43% of 'young' teachers. However, the latter group had been on courses more recently:



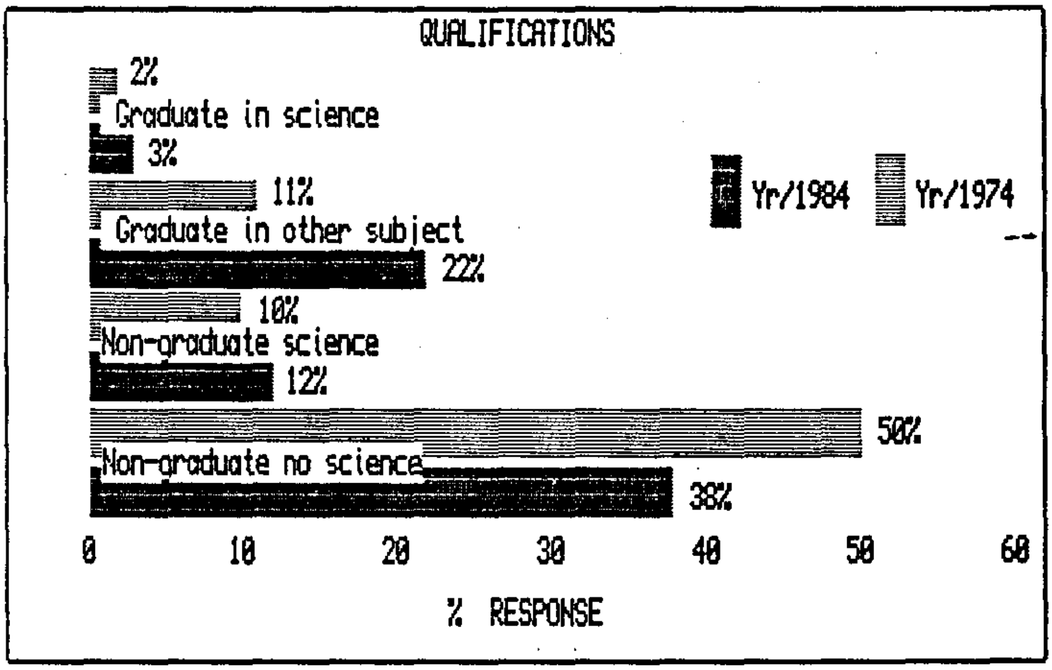
(Data ref. Appendix V 174 - 177)

5) Comparisons with the Bradley (et al.) Report 1974

The sample size of this report is smaller than the Bradley Report (where 136 schools and 628 teachers were questioned), and the objective is somewhat different; Bradley was specifically looking into the requirements of I.N.S.E.T. for primary science. Nevertheless, some trends and results are directly comparable.

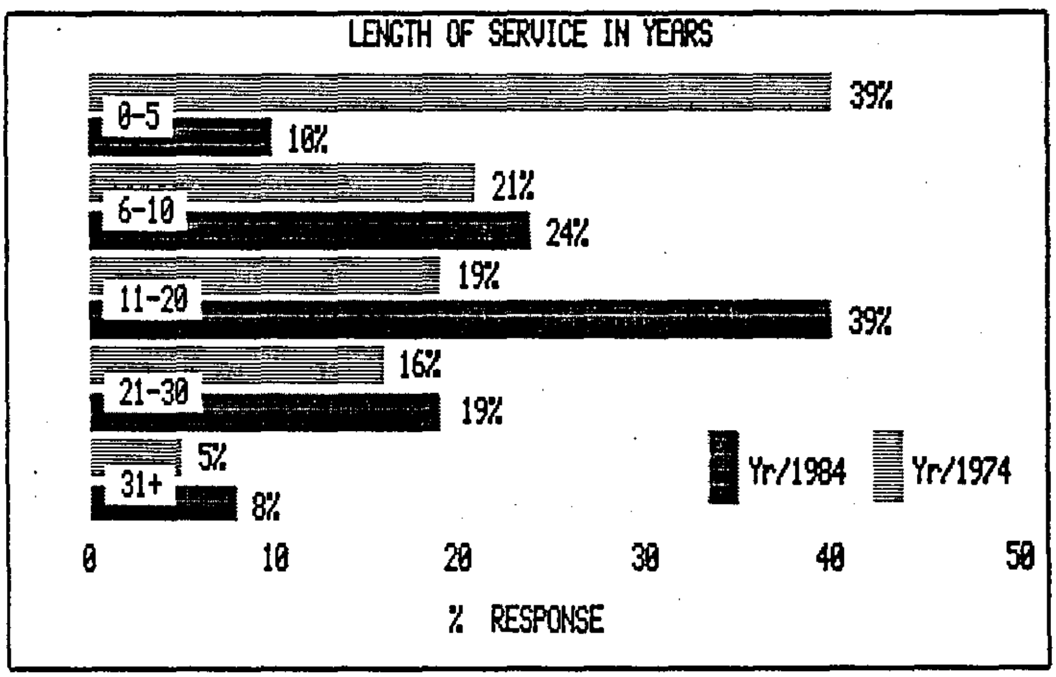
Looking at teachers' qualifications, there are two significant differences. In 1984 25% of teachers are graduates compared with 13% in 1974. Disappointingly however, this does not reflect an increase in science specialists. In 1974 2% of graduates had a science degree, a proportion which has not greatly changed as in 1984 this has only increased to 3%.

The increase in non-science graduates has influenced the non-graduate non-science sample which has accordingly reduced from 50% in 1974 to 38% in 1984.



These differences can be accounted for by the extension and development of the B.Ed. degree and an increase in activity and interest in primary education in University departments.

The shape of the teaching population has changed since 1974. Bradley found that 39% of teachers sampled were in the first five years of their career whereas, by 1984, the bulk of the teachers had taught for 10-20 years. This is probably a reflection of county policy as a result of financial pressures and falling rolls.



The result is that the teaching population has grown older with fewer younger teachers being employed. It would not be unreasonable to speculate that some of the teachers in the 10-20 year experience group in 1984 may have answered the Bradley questionnaire when in the early years of their career.

The pattern of in-service training has also changed over the last ten years.

Attendance on a science-based course:

	1974	1984
None	18%	50%
1 week or less	45%	42%
More than 1 week	34%	8%

The short-course attendance of one week or less has remained almost the same; the major change has been in the attendance on longer courses. This latter has reduced drastically with a corresponding increase in teachers not taking in-service training.

There could be three reasons for this:

i) no courses to attend

ii) no incentive from the L.E.A. to attend courses

iii) no desire to go on courses.

Whilst the third of these probably applies in a number of cases, comments made by the teachers, reinforced by their answers to section 10 of the questionnaire, suggests that there is not enough courses or enough financial support to encourage teachers to apply for places on the courses which exist.

There have been no significant changes in school policy for teaching science/environmental science, although there is a trend which implies that work is becoming planned rather than just left and taken as it arises.

School policy for science/environmental science:

	1974	1984
separate part of the curriculum	12%	9%
planned part of broader topics	32%	45%
as it arises	31%	16%
not at all	1%	0%
no policy	9%	5%
a combination of the above	15%	25%

Of the two science schemes examined, Science 5/13 had fared better during the last decade with more teachers having heard of it and more using it although only 10% said they used it regularly.

Nuffield Science also shows a slight increase in usage but, equally, there is an increase in the teachers who have never heard of it.

	Nuffield		Sc.5/13	
	1974 %	1984	1974 %	1984
never heard of it	1	10	27	12
heard of it but not used	74	59	45	38
occasionally used	17	27	15	40
regularly used	2	4	4	10

6) Concluding Observations.

The policy for environmental science in primary schools has not changed significantly in ten years, beyond a trend for it to be planned into topic work rather than left to be treated 'as it arises'.

The provision and availability of science equipment is described as, at best, adequate; and by half of the teachers questioned as less than adequate or poor.

One third of the schools surveyed had a school site on which environmental science work could take place. These sites varied widely in the facilities they offered, and almost two-thirds of them had been created after the school by voluntary help and/or grant aid.

Local habitats and farm visits were very popular study sites, particularly for schools without a suitable school-based site.

These findings suggest that, despite inadequate provision, schools are finding ways of incorporating environmental science work into their curricula.

Attempts at a national level to provide science schemes has had only a small impact at classroom level. Neither of the schemes investigated was used regularly by more than a few teachers; and some had never heard of them.

The proportion of science specialists in the primary sector has not increased over the last ten years. The introduction of the B.Ed. degree has brought more graduates into primary teaching, but not in science.

The presence of a science specialist in school does make a difference in school policy: environmental science tends to be treated more as a separate subject with a higher percentage of lesson-time allotted. Specific science skills were also rated higher on scales of importance.

The participation in I.N.S.E.T. science-based short courses of one week or less has remained the same but there has been a severe reduction in the number of teachers attending longer courses.

In respect of services and support teachers requested 'more of everything'. There were, however, particularly strong feelings about more financial support for the I.N.S.E.T. and equipment and for better staffing ratios and/or ancillary help to facilitate small group work. Prepared curriculum guidelines, resource materials, and the provision of more in-service courses also took a high priority.

In conclusion, it seems that the climate in which primary science operates in Lincolnshire has changed very little in the last decade. In some cases, it has deteriorated, particularly in attendance on in-service courses.

The recommendations that Bradley made in 1974 are further strengthened by the results of this survey and point to clear directions for all involved in primary education. They are as follows:

1) There must be a much higher in-service course provision. These courses should be of a two-fold nature: to increase the personal scientific knowledge of teachers in order to give them confidence to attempt the teaching of science topics; to provide a clear understanding of the science skills required at primary level and to produce topics specially useful for developing specific skills.

This type of information cannot be assimilated in short courses of a few hours, or even a few days, but needs to be carefully considered over a much longer period of time. It is particularly worrying therefore, to see the severe decrease in attendance on long courses over the last ten years.

2) The facilities and equipment available in schools for science activities are clearly inadequate at the present time. If environmental science is to be successfully taught then 'the environment' must be readily accessible as a source for experiment and investigation. A suitable school site is the obvious answer. This does not have to be elaborate; the corner of a school playing field left unmown, or containers filled with soil for cultivation studies would provide an adequate start for a variety of science activities.

In such investigations 'the environment' will necessarily be brought into the classroom in various forms for further observation and study. It is important that basic equipment is present for such further studies to be carried out and so, a range of suitable measuring, sampling, and magnifying equipment needs to be available in large enough quantities to allow group project work to proceed.

3) In order for the above recommendations to be implemented, more money will have to be provided and a more positive attitude taken to leave of absence for in-service training, financial assistance, and secondment possibilities for teachers to improve their understanding and teaching of science.

4) Such an investment in time and money will need to show maximum returns. The resulting increased impetus and enthusiasm among teachers and be positively channelled and perpetuated by a comprehensive back-up service of advice and support. Opportunities should be created for schools and teachers with successful science programmes and policies in operation to act in an advisory capacity and to provide workshop experience for other schools. One school in an area should be designated as a 'science centre' where equipment and facilities can be built up to be used as a shared facility by other schools within easy access. (Such a scheme is already being attempted in one part of the county.)

5) Teachers and headteachers must be more demanding in requests for provision and services from the L.E.A. If the people at the 'business end' of primary teaching make known their needs and show that they have recognised areas

where help and support is required then, at the very least, the county must listen. Strong views concerning the importance of environmental science were expressed in the survey yet 30% of schools who agreed to take part did not complete the questionnaires. Unless teachers put up a united professional front to expound their views and feelings, the county will have no clear demands upon which to act.

In summary then, certain positive steps have got to be taken if science in general, and environmental science in particular are to be accorded their rightful place in the primary curriculum. It is vital that in-school organisation and outside school support be brought together to produce a much deeper involvement by everyone concerned.

A successful liason of this nature would underpin and promote the development of a scientific/technological awareness and experience in the context of the living environment; an essential prerequisite for young people today.

Let it be hoped then that the next ten years are not as barren as the last and that if this, or a similar survey, is repeated in 1994, a different result would emerge.

Postscript

This whole study has been concerned with the role of environmental science in the primary school. What is happening today is a function of decisions taken in the past. The needs of the future can be determined by an appraisal of the present situation and this, in a small way, is what the author has done.

These findings have been reinforced by a recent report from the D.E.S. entitled 'Education Observed - 2'. The results merited front page space in the Times Educational Supplement (14.12.84.) and several important statements concerning the curriculum were made after a survey of 123 primary and 31 comprehensive schools.

The list makes thoughtful, but all too familiar, reading:

1) Primary schools are spending far too much time on the basic skills of writing and arithmetic.
2) There needs to be greater attention paid to technological awareness.
3) The approach to in-service training is random.
4) Staffing was only 'adequate' and most schools needed more ancillary staff.
5) The basics still dominate the upper primary curriculum, at the expense of good educational standards.
6) Too much time is spent on undemanding and unprofitable formal exercises in English and mathematics is too concerned with computation. It should be more practical than it often is, and set within contexts where work and results are important.

Motivation of teachers.

7) There was little planned progression in science and genuine experimental work was rare.
8) Topic work often lacked coherence of any clear purpose.
9) Even when curriculum guidelines existed outside maths and English, they were often ignored in everyday teaching.

More use of parent expertise?

10) Primary schools should review their specialist strengths.
11) There is a need to ensure a broad approach to basics with work grounded in first-hand experience.

The implications here are plain; if no positive action is taken to remedy the problems which have been revealed, then the future for primary science is bleak. It will continue in the way it has always done; a patchwork of standards ranging from nothing to excellence, and the depth of scientific training a child gets will be based on pure chance, depending upon which school he attends.

In our modern scientific age this is not good enough. If tomorrow's citizens are to make sense of the increasingly sophisticated technology which surrounds them, and contribute to its' further development, then an understanding of scientific principles, coupled with an ability to investigate in a scientific way, is as important as basic literacy and numeracy.

Concern over primary school science has reached government levels. The time is right for some constructive action to ensure the next generation is not scientifically illiterate. Parallel this with an equal concern for the protection and conservation of the environment and 'environmental science' could be the key which opens the door to a future of better informed and caring adults.

Appendix I

Construction details of the major habitats produced.

APPENDIX I

Construction Details for the Major Habitats Produced

1. General

a) Site Preparation

The intended boundaries of the different habitats and paths were initially marked out with pegs and string to ensure correct positioning.

Plate i

Areas that were designated as paths were dug out manually to a depth of approximately 30cm and a layer of hard core laid before concreting commenced. Where it was necessary to have straight sides, wooden shuttering was erected and levels taken.

The large holes required for the ponds, stream, and fen marsh were excavated by a J.C.B. kindly lent, and driven, by a parent.

These activities produced a considerable quantity (approximately 150 tonnes) of unwanted topsoil. This could have been a significant problem but for the efforts of 3 local farmers who came regularly and removed it using tractors and trailers and used it to flatten uneven areas of their land.

It was always important to preplan where materials, debris etc., would be stored as it was highly undesirable to waste precious time continually moving and removing materials unnecessarily. It was also important to keep the site tidy for both aesthetic and safety reasons.

b) Concrete Mixing

Except where stated, concrete was mixed in the standard ratio of 4 gravel: 2 sand: 1 cement. A concrete mixer was hired for the tasks which required high volumes to be made but for smaller quantities, the concrete was mixed manually.

Paving slabs were laid on a 10 sand : 1 cement mix to ensure a solid base. This appears to have worked well as none of the slabs laid show any sign of instability.

Ready-mixed concrete was considered, particularly for the ponds, but was ruled out due to cost and the inaccessibility of the site.

2. The Chequerboard Garden (Plan A)

The area was levelled and marked out. It was decided to lay the paths first and then the chequerboarding. This meant the measurements had to be very precise or the paving slabs would not fit correctly.

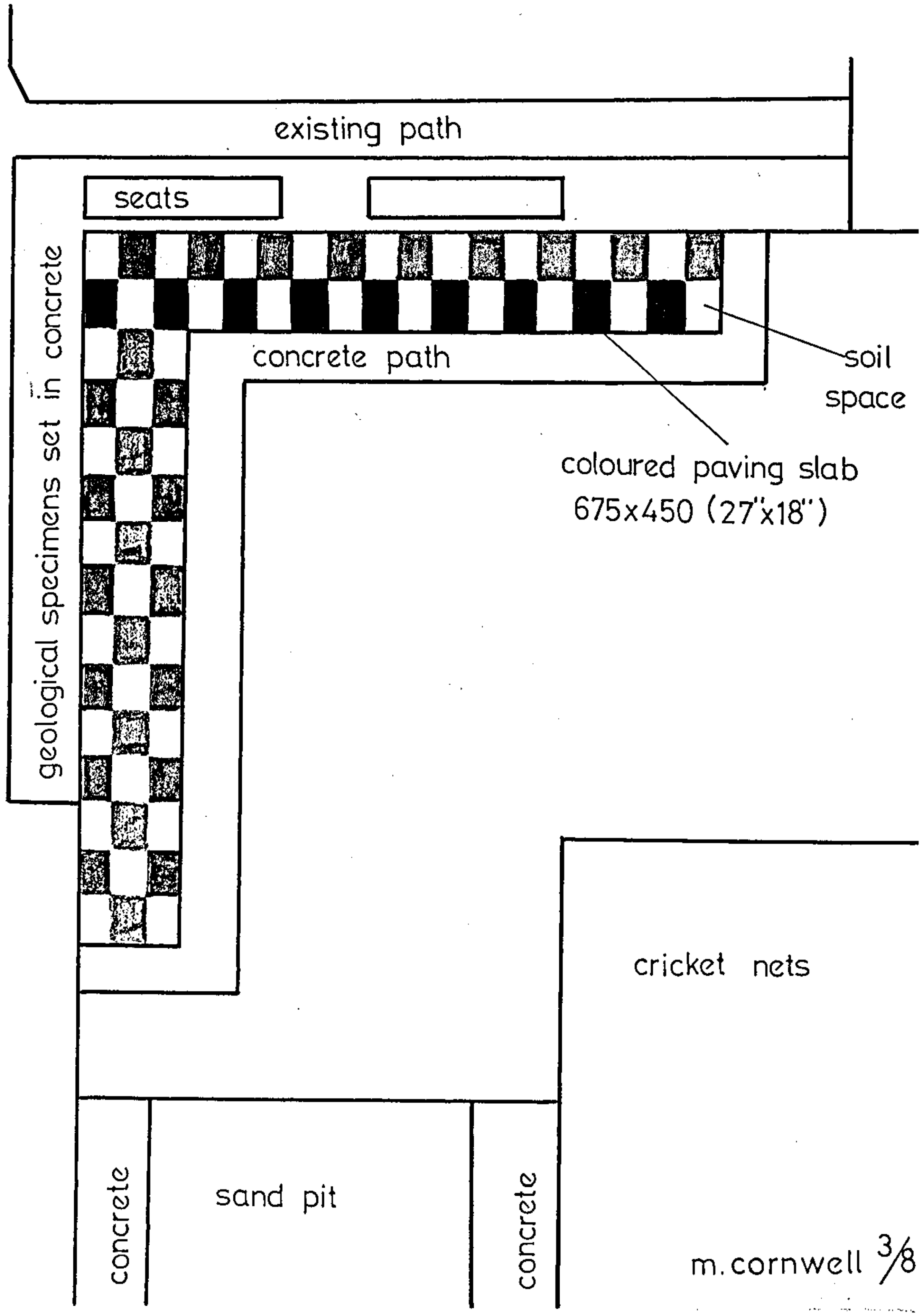
An L-shaped layout was chosen in preference to a solid block to facilitate access to the various plots. The design is such that each child can reach his plot without interrupting anyone working there already, and without getting his feet dirty.

Coloured paving slabs were chosen (a mixture of red, black, brown and beige) as it was felt they were aesthetically more pleasing and afforded some colour during the winter months.

The spaces between the slabs were filled with a mixture of medium loam, sand, and peat to give a good quality growing medium.

The chequerboard garden is kept neat and tidy and is the only 'formal' area on the site.

THE CHEQUERBOARD GARDEN



PLAN A

Plate ii

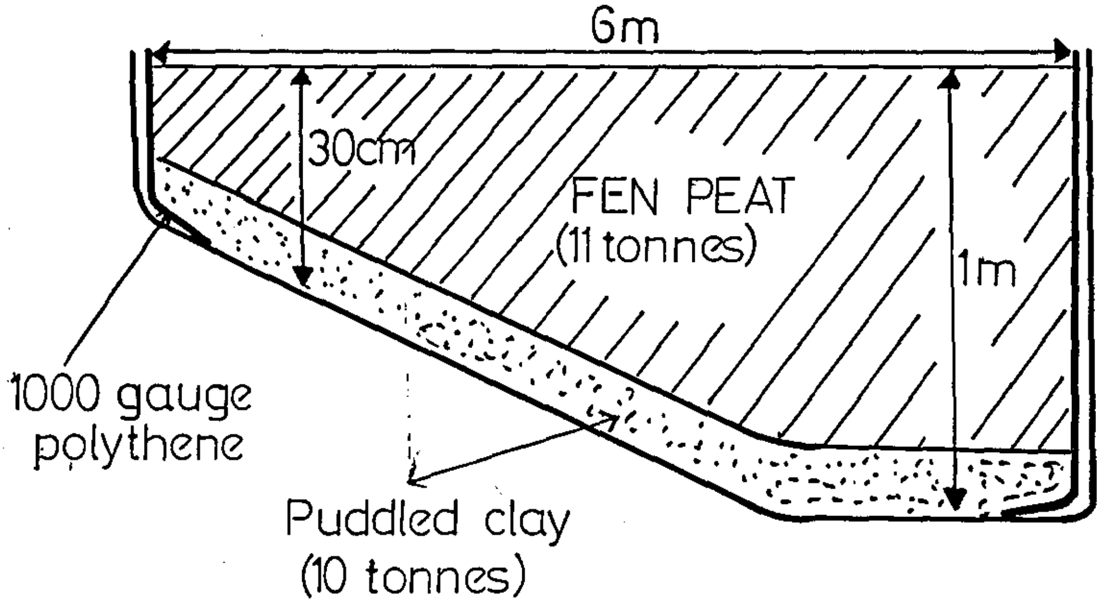
3. <u>The Limestone Mound</u> (Plan B)

The construction of the limestone mound was based on work done by Doyle (1969, 1979) on creating chalk mounds in a school in Hertfordshire. The author decided to use limestone instead of chalk as this was the natural stone of the area, and was readily available from a local quarry at a minimal cost.

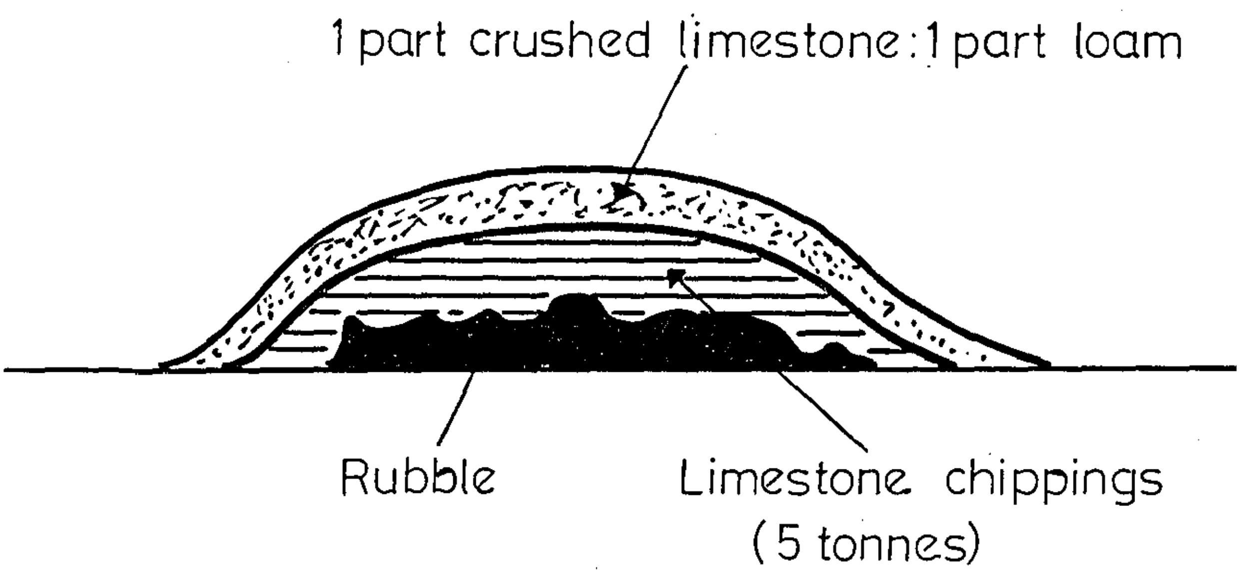
The foundations of the mound consisted of a layer of general building rubble. This would give efficient drainage and allow the useful disposal of some unwanted debris. The rubble was covered by a layer of limestone chippings, five tonnes in all, on top of which was placed the growing medium: a layer of topsoil and crushed limestone, roughly in the ration of 1:1. This consumed a further 5 tonnes of lime.

Selective planting of appropriate species has produced a **dry**, alkaline habitat.

FEN MARSH



LIMESTONE MOUND



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PLAN B

Plate iii

4. The Fen Marsh (Plan B)

To create the fen marsh an area approximately 4m x 6m was measured out which was excavated to a depth of 30cm at one end, sloping to 1m at the other. The sides of this were lined with 1000 gauge polythene to prevent horizontal roots spreading from the surrounding soil. The base of the hole, however, was not lined with plastic as the author was concerned about an excessive acidity build-up due to anaerobic decomposition. Unlike *Sphagnum* bogs, a true fen soil tends to be neutral or slightly alkaline, due mainly to the underlying clays and limestone baserock. There is a much greater species diversity and the peat produced reflects this, being finer textured and closer packed than *Sphagnum* peat. It was with these factors in mind that the author decided to employ the technique of clay-puddling in the base of the hole, to create bad drainage.

The technique of clay-puddling, as used by the Inland Waterways Board, requires clay of a particular quality and a certain amount of skill. Having neither of these pre-requisites, a compromise technique was developed. The formula for this was comparatively simple: a local construction firm delivered 10 tonnes of clay sub-soil from a nearby building site. This was dumped into the bottom of the hole and spread out. Water was hosed onto the clay and groups of children happily donned wellies and old clothes and jumped up and down on the clay, compressing it into a gelatinous, watertight mass. This took three days and a good time was had by all!

Plate iv

The remainder of the hole was then filled with fen peat. The source of this was a local nature reserve where it was being excavated as a commercial concern. Successful liaison with the Nature Conservancy Council resulted in them granting permission for the school to have as much as it needed to complete the area. It took 11 tonnes.

The area was finally watered thoroughly and planted up with suitable plants and seeds.

Pipes were laid for the watering system (see Plan G) and a crazy paving path 30cm wide was built around the perimeter.

Plate v

5. <u>The Pond System</u> (Plans C, D and E)

Any textbook or periodical on water gardens or fish keeping will suggest that the sides of a concrete pond should be stepped to give different water depths and shelves. Thus, it was with this in mind that the first set of plans were drawn up.

Once excavation started it became obvious that there were insurmountable problems with this design. Firstly, the ponds were not neat rectangles but irregular in shape (deliberately so, in order that the final result would look more natural) and secondly, because the ponds were not going to be very deep but rather large, the holes ended up being saucer-shaped.

The overall dimensions were:

Top pond: 5.7m x 4.2m, volume $\simeq$ 10m^3

Stream: 15m x 1m, volume $\simeq$ 5m^3

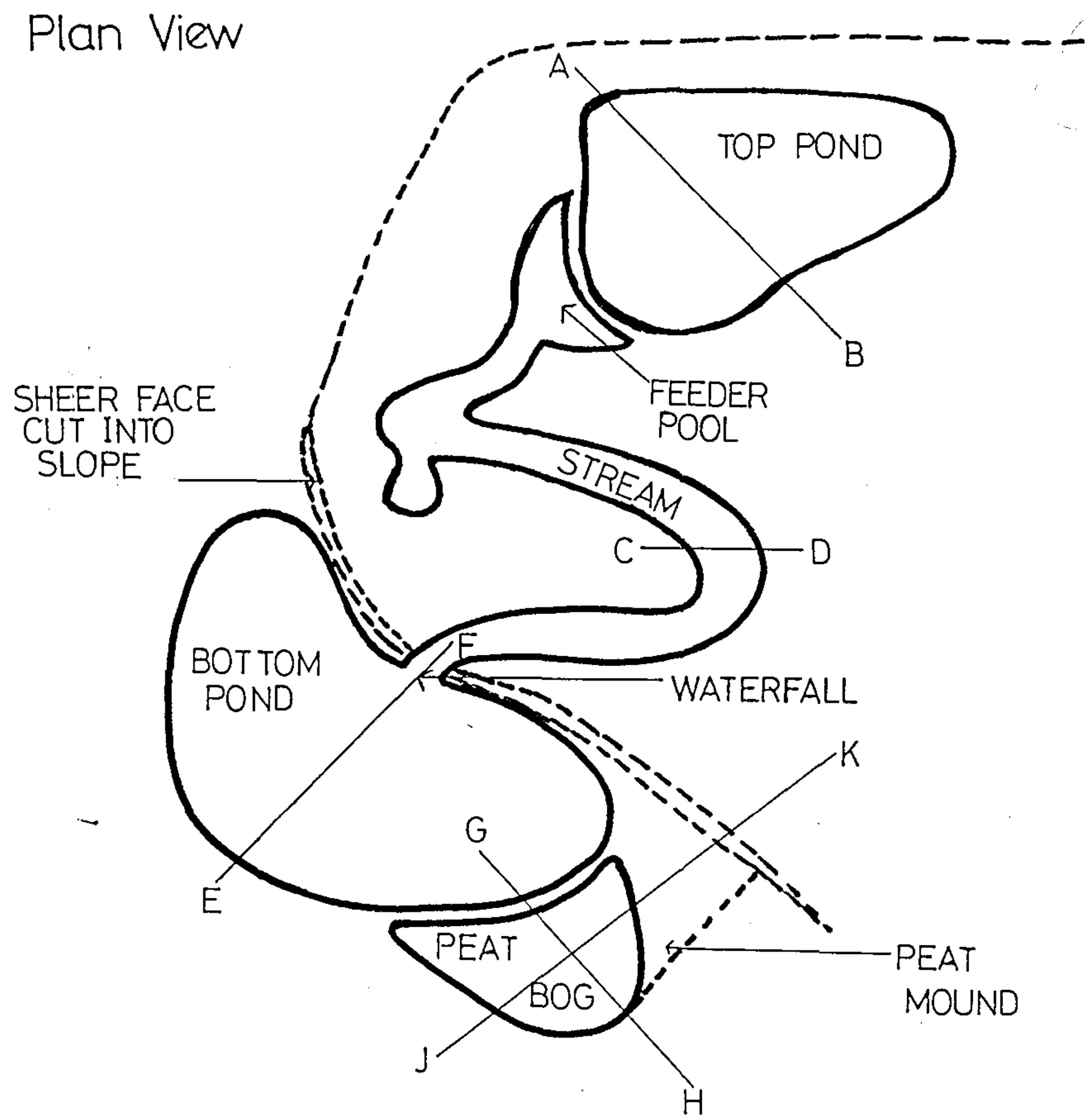
Bottom pond: 12m x 4.5m, volume $\simeq$ 21m^3

The greatest depth was only 80cm. This was sufficient to allow fish protection from ice but shallow enough to be within the safety requirements for school ponds, as laid down by the inspectorate.

It was decided to retain the saucer shape in concrete

POND SYSTEM

Plan View

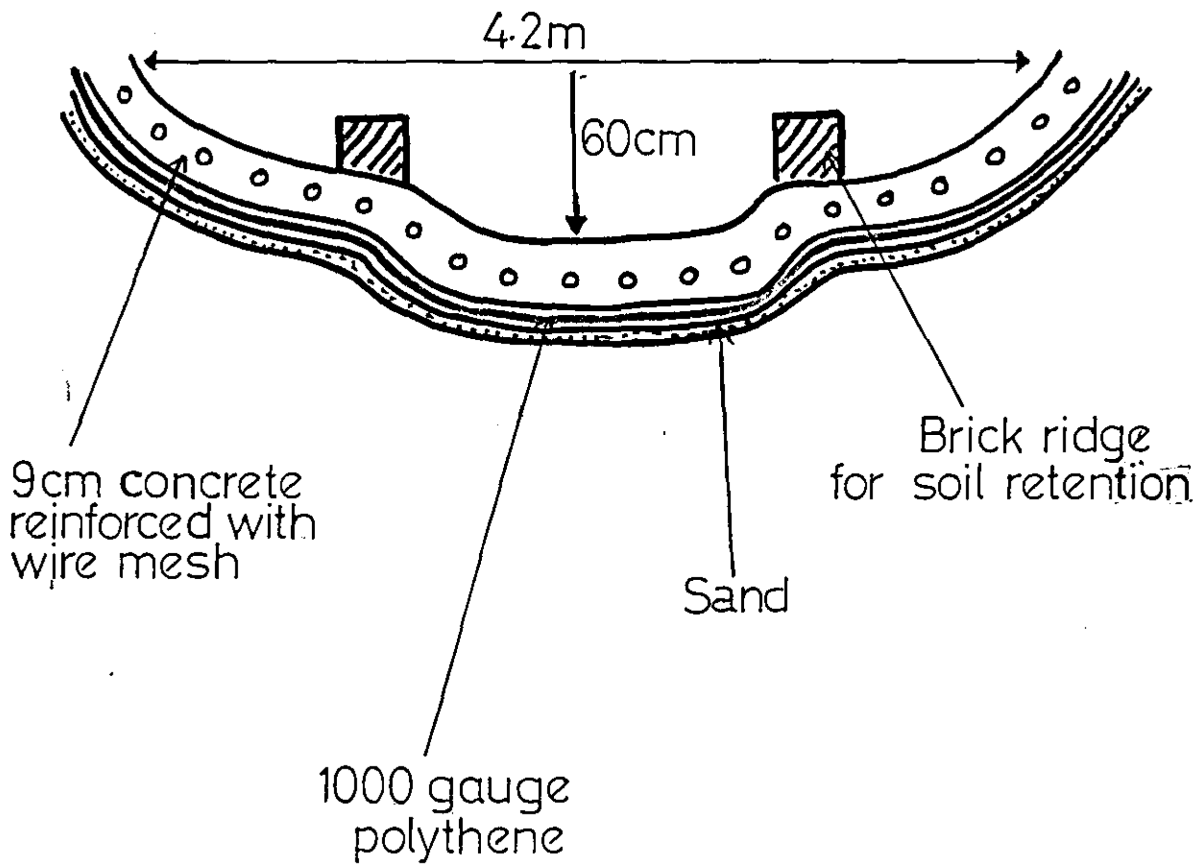


The feeder pool will be 1m. higher than the bottom pond. The water will flow along a stream, down a slight slope, precipitating into the bottom pond and then pumped back up to the feeder pool.

m.cornwell 3/8

PLAN C

① TOP POND A-B



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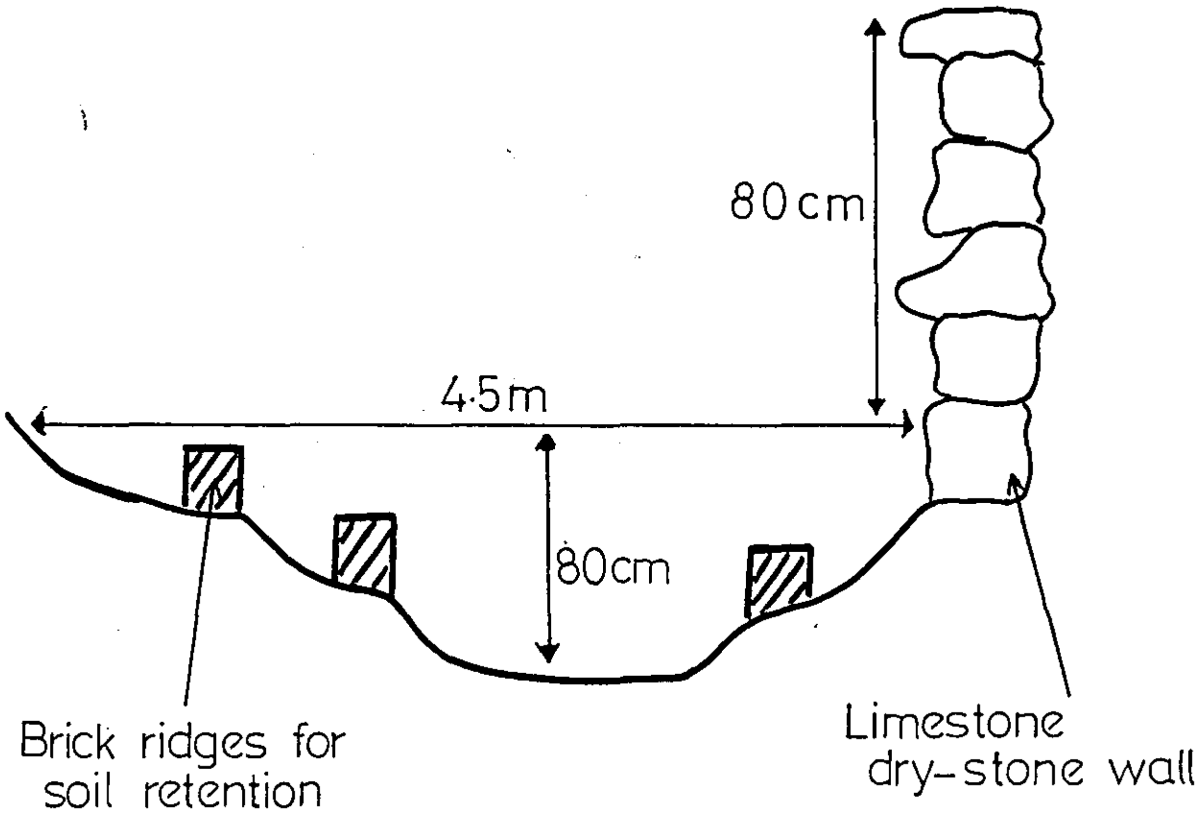
PLAN D

③ E–F BOTTOM POND & WATERFALL

(Construction the same as for top pond)



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PLAN E

and build ridges of bricks at different heights to trap soil for marginal plants. This greatly simplified the construction but still presented some problems. It was imperative to negate any possibility of the concrete cracking or developing leaks and to overcome its natural porosity.

To prevent cracking it was decided to reinforce the concrete using a wide gauge wire mesh of the type used in motorway flyover construction! This was embedded in a concrete layer 10cm thick after the hole had first been lined with sand followed by a layer of 1000 gauge polythene

Plate vi

Once thoroughly set the concrete was then sealed with 'Pondseal', a plastic neutral membrane which is painted on.

Plate vii

The bottom pond was too large to concrete in one session and so was completed in two layers. The lower layer was laid approximately 7cm thick with the reinforcing wire mesh. The surface of this was deliberately left rough and the whole thing allowed to dry thoroughly. A week later a top layer of about 3cm was laid. This was smooth screed made from a sand/cement mix in the ratio of 6 sand: 1 cement which was able to 'key in' to the rough surface of the lower layer and give an extremely smooth finish. This too was sealed with 'Pondseal'.

Plate viii

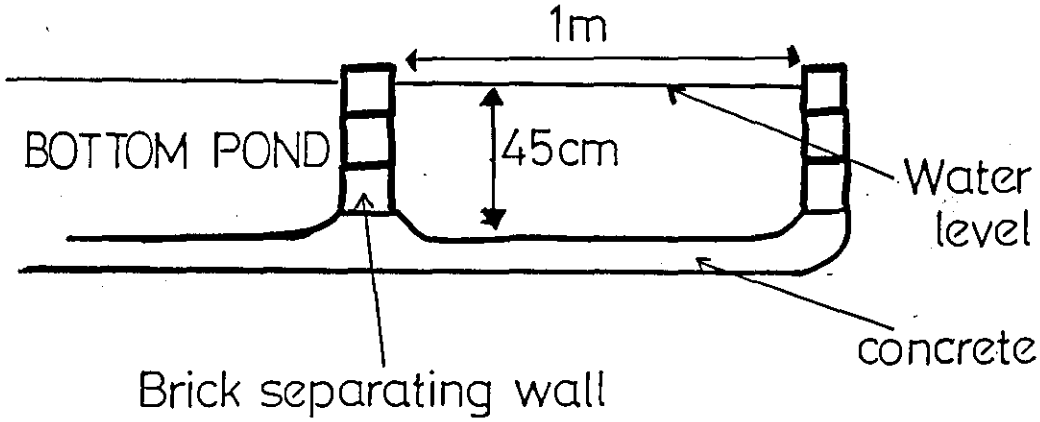
The stream was constructed the same way but, being a much smaller volume of concrete, did not require reinforcement.

6. <u>The Peat Bog</u> (Plan F)

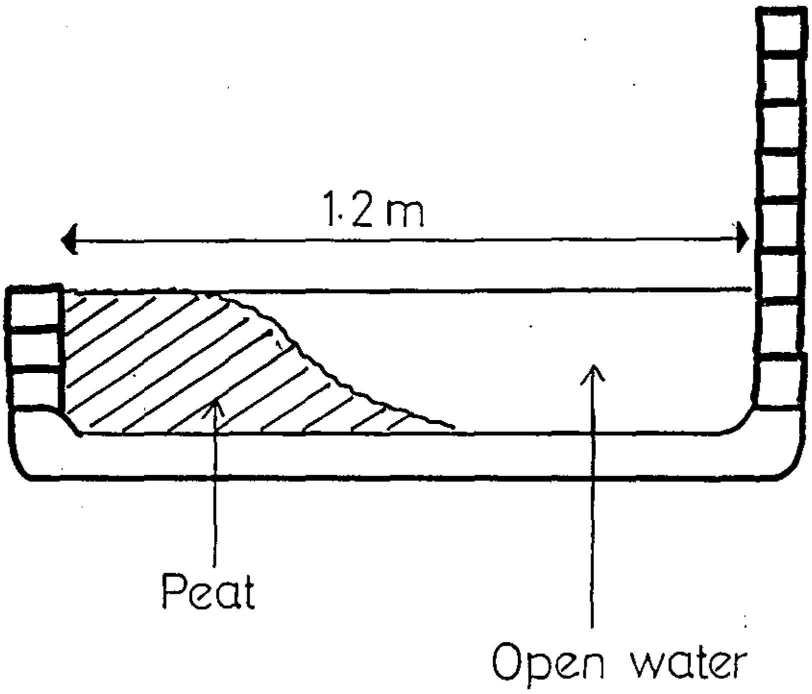
The Peat Bog was constructed at the same time as the bottom pond but is a totally separate system. A brick separating wall and plastic pond liner ensure there is no infiltration of water from the pond. This was partly filled with <u>Sphagnum</u> moss with living sections of <u>Sphagnum</u> bog placed over the top.

④ PEAT BOG

G–H

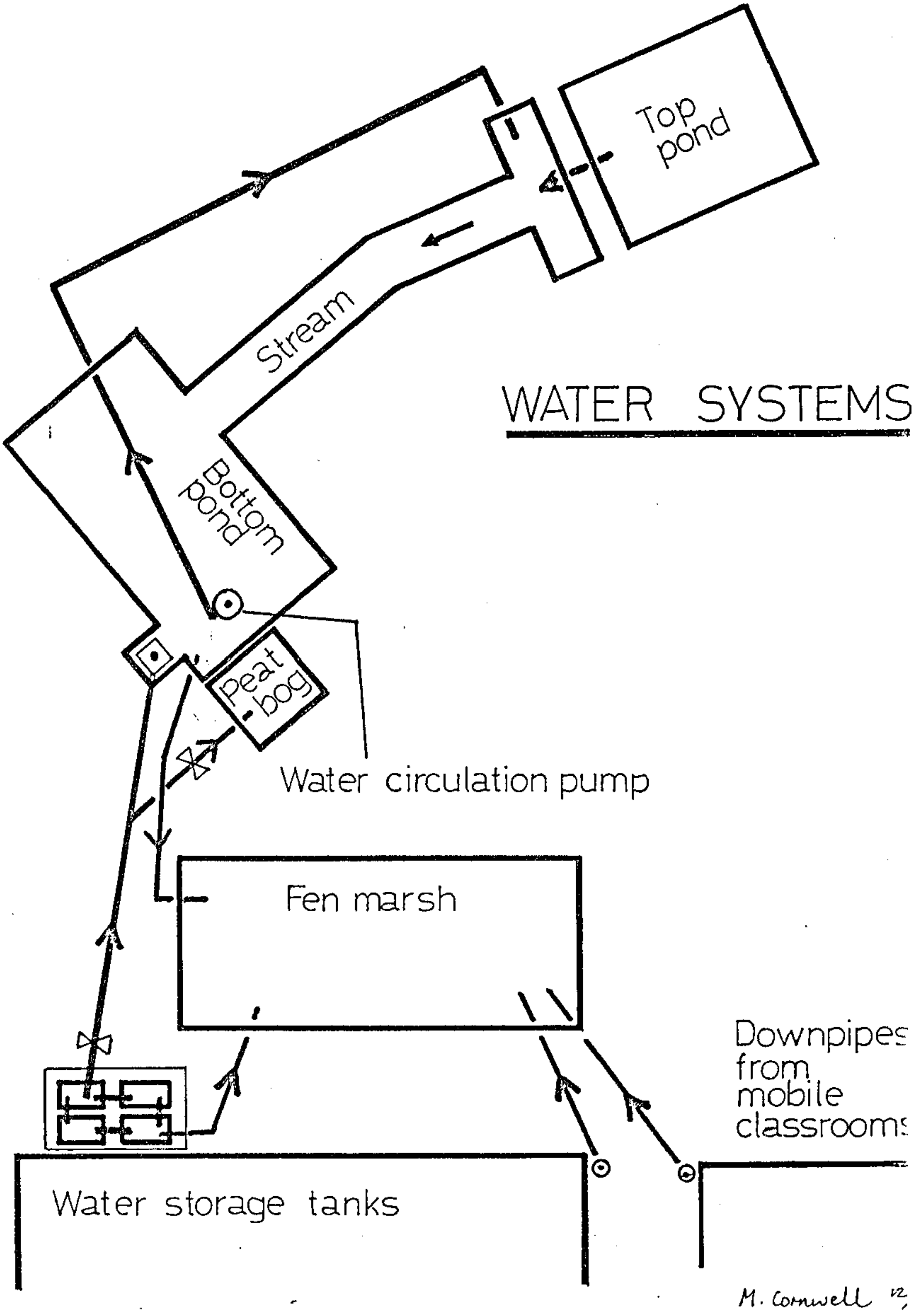


J–K



M.Cornwell 12

PLAN F


Top pond
Stream
WATER SYSTEMS
Bottom pond
peat bog
Water circulation pump
Fen marsh
Downpipes from mobile classrooms
Water storage tanks
M. Cornwell

PLAN G

7. Water Systems:- Circulation Drainage and Refill (Plan G)

Water is circulated from the bottom pond to the top of the stream by a Stuart-Turner submersible pump, of a type designed to pump dirty water.

The top pond has an overflow into the stream and the bottom pond, in turn overflows into the fen marsh. Water is also collected from the downpipes of the two mobile classrooms and piped into the fen marsh.

Four storage tanks have been built on a raised brick and concrete platform. Together they have a storage capacity of 280 gallons. The water is collected from the roof of mobile 1 and stored until needed. This can be done in two ways; 1) by turning off the tap situated at the side of the tanks (marked X on the plan) or 2) by utilising the automatic system controlled by the water level in the bottom pond. This is achieved by the use of a cistern of a type used in domestic toilets (marked [•] on the plan). A ballcock floats on the surface of the water and this operates a valve. When the level is high the valve is shut off but when the water level drops, the ballcock drops, opening the valve and allowing water to enter.

There is a side branch, operated manually by a tap which allows the water level in the peat bog to be supplemented when necessary.

The water tanks have an overflow pipe which empties any excess water into the fen marsh.

Appendix II

The habitat management policy

POND AND STREAM SYSTEM

The Stuart-Turner submersible pump is designed to be maintainance free. If, however, it is necessary to stop it, the on/off switches are in the cupboard off the Infant Hall. The pump is fitted with an automatic cut-out in the event of overheating or mechanical failure.

Due to some seepage and evaporation, the ponds lose about 2-3 cm. water depth per week if there is no rain to top them up. The automatic top-up system works reasonably well, but the tanks empty very quickly during periods of low, or no, rainfall. There is a small advantage during term-time in closing the tap and allowing a large quantity of water to be collected before using it to top up, but during the holidays it is advisable to have the automatic system in use.

After a long period of minimal rainfall (i.e. 2-3 weeks) the level in the bottom pond may have dropped to the second layer of retaining bricks. If this happens, it will be necessary to top up the ponds using a hose and tap water. Although, in general, it is not good practice to use tap water for ponds, greater damage would be caused by allowing the water level to drop too low. The simplest method is to place the hose in the top pond and, as this overflows into the stream, it will fill the whole system.

It is important that the ponds are checked at regular intervals during the summer holidays to ensure the water level has not dropped too much.

The growth of plants in the ponds is astonishingly rapid and some clearance will have to be done from time to time. In practice, it may well be necessary to thin out some plants annually. The best time to remove them is during the period of minimum growth (i.e. October to March) but small amounts of clearance may be done at any time of the year.

The plants around the edges of the ponds are not set in baskets so care must be taken not to chip or damage the surface of the concrete. The best method seems to be to lift the plants up and cut through the root mass with a very sharp knife or saw blade.

The lilies are planted in baskets and so can be raised and separated at the side of the pond. However, this may not be as easy as it sounds as the roots may have grown through the baskets into the bottom ooze.

The unrooted pondweed can just be pulled out from the side using a rake or similar implement.

The only other maintainance required during the year is the removal of any large amounts of blanket-weed, the filamentous green algae. If left to grow it will shade out the other plants as well as looking unattractive.

There is a tendency for plants to seed themselves in gaps between the crazy-paving slabs. These should be pulled out at regular intervals as, if allowed to grow, they will gradually break up the concrete and possibly cause structural damage to the ponds.

THE FEN MARSH

The only maintainance requirement here is to remove selected colonising plants which, if allowed to grow, will impede the growth of the slightly less vigorous fen species. The main offenders are: Chickweed (Stellaria media), creeping thistle (Cirsium arvense), and spear thistle (Cirsium vulgare). Redshank (Polygonium latifolium) and Pale Persicaria (Polygonium persicaria) also need to be monitored to ensure they do not become too prevalent.

The path around the fen marsh needs to be kept clear to minimise invasion of the area by the surrounding coarse grass species.

THE LIMESTONE MOUND

The principal requirement for this area is a twice-yearly cut. The school rotary mower can be used but it is fairly difficult to push up the steep sides, it may be safer to use shears. The area should be cropped in early spring (March/April) to remove any winter growth of course grasses, and again in the autumn (September/October) to remove all summer growth. This mimics the management of old pastures and allows an interesting variety of flowers to grow and bloom. It is most important that the cuttings are removed. If they are left they will act as a mulch, change the composition of the soil, and discourage the growth of desirable plant species.

There are some plants which need to be selected against and these should be removed. They are; creeping thistle (*Cirsium arvense*), broadleaved and curled dock (*Rumex obrusifolius* and *R. crispus*), and stinging nettle (*Urtica dioica*). Their presence causes too much shade and ground cover and will inhibit the growth of preferred species.

CHEQUERBOARD GARDEN

The chequerboard garden should only have in it the plants which are specifically being grown for cultural or experimental purposes and should therefore be 'weeded' in the way a domestic garden would.

At the end of the growing season the individual plots should be cleared and left tidy, except for any plants which are overwintering.

THE WILD AREA

The wild area is, as the name suggests, left alone completely. This area provides important ground cover for frogs, insects, and other fauna. At the edge of this area is a pile of rocks and a pile of wood. These may be carefully removed to observe any animals living under them but should be replaced, as far as possible, in their original positions to cause minimum disturbance.

THE TREE PLANTATION

The trees are planted 1m apart on a grid system and may be left to grow at their own rate. It may be necessary to thin some of them out at a future date, but that is a decision that will have to be taken at the time.

The soil around the trees has been colonised by the usual weeds of cultivation but, if given a similar cutting regime to that of the limestone mound, will become a flower-rich grassland until such time as the tree canopy becomes too dense.

GENERAL RULES FOR THE SAFE USE OF THE NATURE RESERVE

1) Do not go onto the reserve without a teachers permission.
2) Make sure you are wearing suitable clothing for the work you wish to do.
3) No running, shouting, or loud noises.
4) Keep to footpaths whenever possible.
5) Do not collect animals or plants without permission.
6) Do not cause any unnecessary disturbance to wildlife.
7) Have respect for every living thing, however small, and treat it carefully.
8) Make sure any tools or equipment used are cleaned and put away safely.
9) Make sure your feet are clean before entering the school building.
10) Always wash your hands after touching animals or plants.

RULES FOR USING THE POND AND STREAM AREAS

1) Do not lean out so far with a net that you may over-balance.
2) NEVER lean over the high side of the bottom pond.
3) When looking under stones in the stream, always replace them in the position you found them.
4) Always use the bridges to cross the stream; never jump across.
5) Take exteme care if you need to wade into the ponds and never take unnecessary risks.

Appendix III

Examples of the questionnaires used in the survey.

FOR THE HEADTEACHER - Please tick boxes as appropriate.
Tick only one box per question, except in questions 13 &

SCHOOL DETAILS

1. Number of pupils on role:
   - (1) Below 50
   - (2) 51 - 100
   - (3) 101 - 200
   - (4) 201 - 400
   - (5) 401 - 600
   - (6) 600+

2. Total number of teaching staff:
   (Headteacher counts as 1, part-time staff ½)
   - (1) 1 - 2
   - (2) 3 - 4
   - (3) 5 - 8
   - (4) 9 - 12
   - (5) 13 - 16
   - (6) 17 - 20
   - (7) 21 - 24
   - (8) 25+

3. Age range of pupils:
   - (1) 5 - 7
   - (2) 8 - 11
   - (3) 5 - 11
   - (4) Other

ORGANISATION

4. Does the school have:
   - (1) A classroom for each class
   - (2) An open-plan arrangement
   - (3) Some compromise between 1 & 2

5. Is it school policy for pupils' work in environmental science to take place:

(1) As a separate part of the curriculum

(2) As a planned part of some broader topics

(3) As it arises

(4) Not at all

(5) No general policy

(6) Some combination of the above

6. How many science specialists* are there on the staff?
(* i.e. have received substantial formal training in science)

(1) None

(2) 1

(3) 2

(4) 3

(5) 4+

7. Of the science specialists how many were trained in:

(1) Physical Sciences

(2) Biological Sciences

(3) Environmental Sciences

8. Is there a post of responsibility for:

(1) General science

(2) Environmental science

(3) None

9. Do you have a school site for environmental science work:

(1) Yes

(2) No

(If Yes, please answer questions 10-14)
(If No, please answer question 14)

10. Was the outdoor area built:

(1) At the same time as the school

(2) After the school

./.

11. Was it built by:
    - (1) The L.E.A. ☐
    - (2) Voluntary labour ☐
    - (3) Other ☐

    If other, please state details ______________________

    ____

12. Was it funded by:
    - (1) The L.E.A. ☐
    - (2) Fund-raising efforts ☐
    - (3) Grants ☐

    If (3), please state details ______________________

    ____

13. What habitats does the outdoor study area offer?
    - (1) Grassland ☐
    - (2) Ponds ☐
    - (3) Moving water (e.g. stream, river, dyke) ☐
    - (4) Chequerboard garden ☐
    - (5) Garden area ☐
    - (6) Wood (or area of trees) ☐
    - (7) Tree nursery ☐
    - (8) Marsh ☐
    - (9) Bird table/nest boxes ☐
    - (10) Other ☐

    If (10), please give details: ______________________

    ____

    ____

14. Does environmental science take place outside the school grounds in the form of:

(1) Local habitats ☐

(2) Nature reserves ☐

(3) Field Study centres ☐

(4) Museums ☐

(5) Zoo/Wildlife Park ☐

(6) Wildfowl/Bird centres ☐

(7) Farm visits ☐

(8) Gardens/parks ☐

(9) Other ☐

If (9), please give further details: ____________________

____

____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

For Every Teacher,

For questions 1 - 5 and 11 - 22 please indicate your reply by putting a tick in the appropriate boxes to show YOUR views.

For questions 6 - 10 please circle the number which indicates your opinion on the scale for which the two extremes are given.

Example

Environmental science should be taught separately in every primary school curriculum	TOTALLY DISAGREE	1	2	3	4	5	6	COMPLETELY AGREE

Circling 1 would indicate that you totally disagree with the statement.

Circling 4 would indicate that you agree with the statement but have strong reservations.

Circling 5 would indicate you agree, with minor reservations.

Circling 6 would indicate you completely agree with the statement.

Organisation

1. Is classwork in environmental science:

	YES	NO
(1) A specified part of the curriculum		
(2) A planned part of broader topics		
(3) Developed as it arises		
(4) Not done		

2. Is there:

	YES	NO
(1) A scheme of work available		
(2) A set of broad guidelines		
(3) No general policy		

3. What percentage of total lesson time is spent on environmental science activities?

    (1) 0%
    (2) 5%
    (3) 10%
    (4) 15%
    (5) 20%

4. How would you describe the available first hand facilities of equipment and/or working areas for teaching environmental science?

    (1) Poor
    (2) Less than adequate
    (3) Adequate
    (4) Good
    (5) Excellent

5. What, on average, is the size of group undertaking environmental sciences simultaneously?

    (1) Less than 5
    (2) 6 - 10
    (3) 11 - 15
    (4) 16 - 20
    (5) 21 - 25
    (6) 26 - 30
    (7) 31+

6. Please rate the following aspects of environmental science education according to the importance you feel each should have for the children you teach:

Tick the age-group you teach:

L.I.	U.I.	L.J.	U.J.

The ability to:

	not important							essent
(1) Follow carefully instructions from a work card, book or blackboard		1	2	3	4	5	6	
(2) Make notes of observations/results during the course of their work		1	2	3	4	5	6	
(3) Make a satisfactory written record of work		1	2	3	4	5	6	
(4) Decide the aspect of the topic they wish to study/investigate		1	2	3	4	5	6	
(5) Choose what kind of record to make of their work		1	2	3	4	5	6	
(6) Make careful, first hand observations		1	2	3	4	5	6	
(7) Make drawings from first hand observations		1	2	3	4	5	6	
(8) Write from first hand observations		1	2	3	4	5	6	
(9) Design own experiments/investigations		1	2	3	4	5	6	
(10) Identify the variables operating in certain situations		1	2	3	4	5	6	
(11) Draw conclusions from results or make generalisations based on observations		1	2	3	4	5	6	
(12) Use reference books for further information		1	2	3	4	5	6	

7. Which of these do you consider to be the most important goals in environmental science?

Development of:

	not important							essent
(1) Understanding of basic concepts such as habitat differences, living requirements, food webs etc.		1	2	3	4	5	6	
(2) Problem solving skills		1	2	3	4	5	6	
(3) The ability to carry out simple investigations/experiments carefully and safely		1	2	3	4	5	6	
(4) The enjoyment of environmental activities		1	2	3	4	5	6	
(5) A knowledge of the natural world around us		1	2	3	4	5	6	
(6) The ability to observe carefully		1	2	3	4	5	6	
(7) A questioning attitude towards surroundings		1	2	3	4	5	6	
(8) A respect and appreciation of the natural world		1	2	3	4	5	6	

(9) The ability to find information from reference books	not important	1	2	3	4	5	6	essent:
(10) The ability to use basic equipment safely and accurately		1	2	3	4	5	6	
(11) Creative skills such as art, descriptive and imaginative writing, etc.		1	2	3	4	5	6	

8. Which of these teaching schemes and materials are you familiar with?

Nuffield Science	not heard of it	1	2	3	4	5	6	used regular
Science 5/13		1	2	3	4	5	6	

9. How much use do you make of T.V./radio programmes on environmental science?

	None	1	2	3	4	5	6	regular

10. In what way would you like back-up resources from the L.E.A.?

(1) More courses to attend	not important	1	2	3	4	5	6	essenti
(2) A greater availability of the advisory service		1	2	3	4	5	6	
(3) A course based at your school		1	2	3	4	5	6	
(4) More financial assistance		1	2	3	4	5	6	
(5) Prepared guidelines in curriculum content		1	2	3	4	5	6	
(6) Prepared guidelines for equipment buying		1	2	3	4	5	6	

(7) Please state any other you feel important

------ --------------------------

Personal Details

11. Male ☐
Female ☐

12. Graduate in:

(1) Environmental sciences ☐

(2) Biological sciences ☐

(3) Physical sciences ☐

(4) Other subject ☐

(4)a. If B.Ed. please state main subject: (other than education) ______________

./..

13. Non-graduate, main subject:
    (1) Environmental sciences ☐
    (2) Biological sciences ☐
    (3) Physical sciences ☐

14. Non-graduate:
    (1) Some science but not main subject ☐
    (2) Not trained in science ☐

15. Graduate or non-graduate, did you attend science-based curriculum courses?
    (1) Environmental sciences ☐
    (2) Biological sciences ☐
    (3) Physical sciences ☐
    (4) General science ☐
    (5) None ☐

16. Were you primary or secondary trained?
    (1) Primary ☐
    (2) Secondary ☐

17. A-levels:
    (1) Physics ☐
    (2) Chemistry ☐
    (3) Biology ☐
    (4) Other science subject ☐

    If (4) please state details:

18. O-levels:
    (C.S.E.)
    (1) Physics ☐
    (2) Chemistry ☐
    (3) Biology ☐
    (4) Other science subject ☐

    If (4) please state details:

19. Have you ever attended a science-based course during your teaching career?

    (1) Yes

    (2) No

    If Yes - continue

    If No - please go to question 21.

20. What has been your total involvement in science-based I.N.S.E.T. since 1st Sept. 1980?

    (1) None

    (2) 1 - 6 hours

    (3) 7 - 15 hours

    (4) 16 - 30 hours (Assume 30 hour = 1 week)

    (5) 1 - 2 weeks

    (6) 2 - 4 weeks

    (7) 4 weeks - 1 term

    (8) 1 term - 1 year

21. How many years teaching experience do you have?

    (1) 0 - 5

    (2) 6 - 10

    (3) 11 - 20

    (4) 21 - 30

    (5) 31+

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

Appendix IV

Details of the statistical analysis

1) <u>A Test of Difference of Proportions</u>

In results involving single sample proportions, it is necessary to know whether the difference between them is significant. This difference can be treated as a special case of a difference between two means.

If the comparison is to be between two independent random samples, the following null hypothesis can be formulated:

$$Pu_1 = Pu_2$$

i.e. that the proportions of prejudiced persons in the two populations are equal.

The following series of formulae may now be used to calculate the z-score.

$$\hat{P}u = \frac{N_1 p_{s_1} + N_2 p_{s_2}}{N_1 + N_2}$$

then

$$\hat{q}_u = 1 - \hat{p}_u$$

then

$$\sigma^1 p_{s_1} - p_{s_2} = \sqrt{\hat{p}u \; \hat{q}u}\sqrt{\frac{N_1 + N_2}{N_1 N_2}}$$

then

$$z = \frac{(p_{s_1} - p_{s_2}) - 0}{\hat{\sigma} - p_{s_1} - p_{s_2}}$$

This can be shown in a worked example.

The proportion of male graduates was found to be 29 out of a sample of 74, i.e. 39%. The proportion of female graduates was 38 out of a sample of 188 female teachers, i.e. 20%.

Is the difference between 39% and 20% a significant one?

The null hypothesis is that the proportion of male graduates is the same as the proportion of female graduates.

$$\hat{p}u = \frac{74(.39) + 188(.20)}{74 + 188} = 0.254$$

$$\hat{q}u = 1 - 0.254 = 0.746$$

$$\sigma p_{s_1} - p_{s_2} = \sqrt{(.254)(.746)}\sqrt{\frac{74 + 188}{(74)(188)}}$$

$$= (0.435)(0.138) = 0.06.$$

$$z = \frac{.74 - .188}{.06} = \underline{\underline{9.2}}$$

An answer of 1.65 or more is significant at the 5% level and thus, the difference is very significant and the null hypothesis may be rejected.

2) <u>Testing the Difference Between Means</u>

On the sections on the questionnaire where teachers have been asked to score along a gradient of importance of 1-6, a mean score has been calculated.

To find out if the two subsets are significantly different from each other, the two means have to be compared. This can be done using a t-test for uncorrelated data and takes the following formula.

$$t = \frac{M_1 - M_2}{\sqrt{\frac{SD_1^2}{N_1} + \frac{SD_2^2}{N_2}}}$$

Example:

The questions asked teachers to rate "the ability to make a satisfactory written record of work" along a 6 point scale, according to importance for the children they teach.

The following responses were obtained:

Infant teachers	Number = 107 (N_1)	Mean = 3.21 (M_1)	Standard Deviation = 1.74 (SD_1)
Junior teachers	Number = 155 (N_2)	Mean = 4.76 (M_2)	Standard Deviation = 1.17 (SD_z)

The null hypothesis is that there is no difference in a consideration of level of importance of the above statement between infant and junior teachers.

$$t = \frac{3.21 - 4.76}{\sqrt{\frac{(1.74)^2}{107} + \frac{(1.17)^2}{155}}}$$

$$= - \frac{1.55}{0.2} = 7.75$$

degrees of freedom = 130.

∴ There is a significant difference at the 1% level and the null hypothesis is rejected.

3) <u>Testing differences in rank order</u>

It was necessary to find out which factors, if any, affected the rank order of importance of skills and goals in environmental science.

Spearmans rank order correlation test was used for this, as the following example shows:

6. Please rate the following aspects of environmental science education according to the importance you feel each should have for the children you teach:

The ability to:	Variable X Infant teachers Mean	Variable X Junior teachers Mean
(1) Follow carefully instructions from a work card, book or blackboard.	2.92	4.87
(2) Make notes of observations/results during the course of their work.	2.96	4.99
(3) Make a satisfactory written record of work.	3.21	4.76
(4) Decide the aspect of the topic they wish to study/investigate.	2.69	3.68
(5) Choose what kind of record to make of their work.	2.74	3.73
(6) Make careful, first hand observations.	5.04	5.48
(7) Make drawings from first hand observations.	4.54	5.05
(8) Write from first hand observations.	3.93	4.99
(9) Design own experiments/investigations	2.67	4.08
(10) Identify the variables operating in certain situations.	2.84	4.26
(11) Draw conclusions from results or make generalisations based on observations.	4.16	5.16
(12) Use reference books for further information.	4.17	5.21

The null hypothesis is that there is no correlation between the rank order placings of infant and junior teachers, i.e. they are different populations.

$$r_s = 1 - \frac{6\sum d^2}{n(n-1)(n+1)}$$

where

d= the difference between the items in a pair

n= the number of items

Σ= the sum of

Item	Infant	Junior	d	d^2
1	2.92	4.87	-1.95	3.80
2	2.96	4.99	-2.03	4.12
3	3.21	4.76	-1.55	2.40
4	2.69	3.68	-0.99	0.98
5	2.74	3.73	-0.99	0.98
6	5.04	5.48	-0.44	0.19
7	4.54	5.05	-0.51	0.26
8	3.93	4.99	-1.06	1.12
9	2.67	4.08	-1.41	1.99
10	2.84	4.26	-1.42	2.02
11	4.16	5.16	-1.00	1.00
12	4.17	5.21	-1.04	1.08
			Σ =	19.94

$$r_s = 1 - \frac{6(19.94)}{12(11)(13)} = 1 - \frac{119.64}{1716} = 0.93$$

This is a significant correlation at the 1% level thus, the null hypothesis is rejected.

Appendix V

The raw data

FOR THE HEADTEACHER - Please tick boxes as appropriate.
Tick only one box per question, except in questions 13 & 14.

SCHOOL DETAILS

	No.	% response
1. Number of pupils on role:		
(1) Below 50	9	16
(2) 51 - 100	17	30
(3) 101 - 200	10	18
(4) 201 - 400	16	29
(5) 401 - 600	4	7
(6) 600+	0	0
2. Total number of teaching staff: (Headteacher counts as 1, part-time staff ½)		
(1) 1 - 2	11	20
(2) 3 - 4	18	32
(3) 5 - 8	12	22
(4) 9 - 12	11	20
(5) 13 - 16	3	5
(6) 17 - 20	1	1
(7) 21 - 24	0	0
(8) 25+	0	0
3. Age range of pupils:		
(1) 5 - 7	3	5
(2) 8 - 11	4	7
(3) 5 - 11	43	77
(4) Other	6	11

ORGANISATION

	No.	% response
4. Does the school have:		
(1) A classroom for each class	49	88
(2) An open-plan arrangement	0	0
(3) Some compromise between 1 & 2	7	12

5. Is it school policy for pupils' work in environmental science to take place:

	No.	% response	
(1) As a separate part of the curriculum	5	9	
(2) As a planned part of some broader topics	25	45	
(3) As it arises	9	16	
(4) Not at all	0	0	
(5) No general policy	3	5	
(6) Some combination of the above	16	25	n=55

6. How many science specialists* are there on the staff?
(* i.e. have received substantial formal training in science)

(1) None	37	66	
(2) 1	14	25	
(3) 2	4	7	
(4) 3	1	2	
(5) 4+	0	0	

7. Of the science specialists how many were trained in:

(1) Physical Sciences	9	41	
(2) Biological Sciences	4	18	
(3) Environmental Sciences	9	41	n=22

8. Is there a post of responsibility for:

(1) General science	7	13	
(2) Environmental science	4	8	
(3) None	42	79	n=53

9. Do you have a school site for environmental science work:

(1) Yes	20	36	
(2) No	36	64	

(If Yes, please answer questions 10-14)
(If No, please answer question 14)

10. Was the outdoor area built:

(1) At the same time as the school	8	40	
(2) After the school	12	60	n=20

11. Was it built by:

		No.	% response	
(1)	The L.E.A.	8	40	
(2)	Voluntary labour	6	30	
(3)	Other	5	25	n=20

If other, please state details _

_ _

12. Was it funded by:

(1)	The L.E.A.	12	60	
(2)	Fund-raising efforts	9	45	
(3)	Grants	5	15	n=20

If (3), please state details _

_ _

13. What habitats does the outdoor study area offer?

(1)	Grassland	12	60	
(2)	Ponds	11	55	
(3)	Moving water (e.g. stream, river, dyke)	2	10	
(4)	Chequerboard garden	8	40	
(5)	Garden area	8	40	
(6)	Wood (or area of trees)	10	50	
(7)	Tree nursery	6	30	
(8)	Marsh	5	25	
(9)	Bird table/nest boxes	15	75	
(10)	Other	1	5	n=20

If (10), please give details: _

_ _

_ _

./..

14. Does environmental science take place outside the school grounds in the form of:

		No.	% response	
(1)	Local habitats	43	77	
(2)	Nature reserves	20	36	
(3)	Field Study centres	22	39	
(4)	Museums	25	45	
(5)	Zoo/Wildlife Park	28	50	
(6)	Wildfowl/Bird centres	15	27	
(7)	Farm visits	32	57	
(8)	Gardens/parks	25	45	
(9)	Other	7	13	n=56

If (9), please give further details: _

_ _

_ _

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

FOR THE HEADTEACHER - Please tick boxes as appropriate.
Tick only one box per question, except in questions 13 & 14.

SCHOOL DETAILS

1. Number of pupils on role:

(1)	Below 50	SMALL SCHOOLS = 26 = 46%
(2)	51 - 100	
(3)	101 - 200	LARGE SCHOOLS = 30 = 54%
(4)	201 - 400	
(5)	401 - 600	
(6)	600+	

2. Total number of teaching staff:
(Headteacher counts as 1, part-time staff ½)

		SMALL SCHOOLS No.	%	LARGE SCHOOLS No.	%
(1)	1 - 2	11	42	0	0
(2)	3 - 4	15	58	3	10
(3)	5 - 8	0	0	12	40
(4)	9 - 12	0	0	11	37
(5)	13 - 16	0	0	3	10
(6)	17 - 20	0	0	1	3
(7)	21 - 24	0	0	0	0
(8)	25+	0	0	0	0

3. Age range of pupils:

(1)	5 - 7	1	4	2	7
(2)	8 - 11	0	0	4	14
(3)	5 - 11	23	88	20	67
(4)	Other	2	8	4	12

ORGANISATION

4. Does the school have:

(1)	A classroom for each class	22	85	27	90
(2)	An open-plan arrangement	0	0	0	0
(3)	Some compromise between 1 & 2	4	15	3	10

5. Is it school policy for pupils' work in environmental science to take place:

	SMALL No.	SMALL %	LARGE No.	LARGE %
(1) As a separate part of the curriculum	3	12	2	7
(2) As a planned part of some broader topics	11	42	13	45
(3) As it arises	4	15	5	17
(4) Not at all	0	0	0	0
(5) No general policy	1	4	2	7
(6) Some combination of the above	7	27	7	24

6. How many science specialists* are there on the staff?
(* i.e. have received substantial formal training in science)

(1) None	19	73	18	60
(2) 1	6	23	8	27
(3) 2	1	4	3	10
(4) 3	0	0	1	3
(5) 4+	0	0	0	0

7. Of the science specialists how many were trained in:

(1) Physical Sciences	1	13	8	53
(2) Biological Sciences	2	38	2	13
(3) Environmental Sciences	4	50	3	20
	n=7		n=15	

8. Is there a post of responsibility for:

(1) General science	0	0	7	24
(2) Environmental science	1	4	6	21
(3) None	25	96	17	55
	n=25		n=29	

9. Do you have a school site for environmental science work:

(1) Yes	9	35	11	37
(2) No				

(If Yes, please answer questions 10-14)
(If No, please answer question 14)

10. Was the outdoor area built:

(1) At the same time as the school	5	56	3	27
(2) After the school	4	44	8	73

		SMALL (n=9) No.	%	LARGE (n=11) No.	%
11.	**Was it built by:**				
	(1) The L.E.A.	1	11	7	64
	(2) Voluntary labour	3	33	3	27
	(3) Other	5	56	0	0

If other, please state details ______________________

____

		SMALL No.	%	LARGE No.	%
12.	**Was it funded by:**				
	(1) The L.E.A.	5	56	7	64
	(2) Fund-raising efforts	5	56	4	37
	(3) Grants	2	8	1	9

If (3), please state details ______________________

____

		SMALL No.	%	LARGE No.	%
13.	**What habitats does the outdoor study area offer?**				
	(1) Grassland	5	56	7	64
	(2) Ponds	5	56	6	54
	(3) Moving water (e.g. stream, river, dyke)	2	22	0	0
	(4) Chequerboard garden	4	44	4	37
	(5) Garden area	5	56	3	27
	(6) Wood (or area of trees)	4	44	6	54
	(7) Tree nursery	3	33	3	27
	(8) Marsh	3	33	2	18
	(9) Bird table/nest boxes	8	89	7	64
	(10) Other	0	0	1	9

If (10), please give details: ______________________

____

____

./..

		SMALL n=26		LARGE n=30	
		No.	%	No.	%

14. Does environmental science take place outside the school grounds in the form of:

		No.	%	No.	%
(1)	Local habitats	20	77	23	77
(2)	Nature reserves	8	30	12	40
(3)	Field Study centres	9	35	13	43
(4)	Museums	13	50	12	40
(5)	Zoo/Wildlife Park	14	54	14	47
(6)	Wildfowl/Bird centres	8	30	7	23
(7)	Farm visits	17	65	15	50
(8)	Gardens/parks	8	30	17	57
(9)	Other	6	23	1	3

If (9), please give further details: ___________________

____

____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

THE EFFECT OF A SCHOOL SITE ON USE OF OUTSIDE RESOURCES

14. Does environmental science take place outside the school grounds in the form of:

	SCHOOL SITE No.	SCHOOL SITE %	NO SITE No.	NO SITE %
(1) Local habitats	15	75	28	78
(2) Nature reserves	4	20	16	44
(3) Field Study centres	7	35	15	42
(4) Museums	8	40	17	47
(5) Zoo/Wildlife Park	9	45	19	53
(6) Wildfowl/Bird centres	3	15	12	20
(7) Farm visits	12	60	20	56
(8) Gardens/parks	7	35	18	50
(9) Other	4	20	3	8

If (9), please give further details: ____________________

____

____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

HEADTEACHERS QUESTIONNAIRE

THE EFFECT OF THE PRESENCE OF A SPECIALIST WITH REGARDS TO SCHOOL POLICY

5. Is it school policy for pupils' work in environmental science to take place:

	SPECIALIST NO.	SPECIALIST %	NON-SPECIALIST NO.	NON-SPECIALIST %
(1) As a separate part of the curriculum	3	16	2	6
(2) As a planned part of some broader topics	6	31	19	53
(3) As it arises	2	11	7	19
(4) Not at all	0	0	0	0
(5) No general policy	2	11	1	3
(6) Some combination of the above	6	31	7	19
	n=19		n=36	

6. How many science specialists* are there on the staff?
(* i.e. have received substantial formal training in science)

	NO.	%
(1) None	37	66%
(2) 1 (3) 2 (4) 3 (5) 4+	19	34%

7. Of the science specialists how many were trained in:

(1) Physical Sciences

(2) Biological Sciences

(3) Environmental Sciences

8. Is there a post of responsibility for:

(1) General science

(2) Environmental science

(3) None

9. Do you have a school site for environmental science work:

	SPECIALIST NO.	SPECIALIST %	NON-SPECIALIST NO.	NON-SPECIALIST %
(1) Yes	8	42	12	32
(2) No				

(If Yes, please answer questions 10-14)
(If No, please answer question 14)

10. Was the outdoor area built:

(1) At the same time as the school

(2) After the school

		SPECIALIST n=19		NON-SPECIALIST n=37	

14. Does environmental science take place outside the school grounds in the form of:

		No.	%	No.	%
(1)	Local habitats	13	68	30	81
(2)	Nature reserves	8	42	12	32
(3)	Field Study centres	8	42	14	38
(4)	Museums	7	37	18	49
(5)	Zoo/Wildlife Park	8	42	20	54
(6)	Wildfowl/Bird centres	5	26	10	27
(7)	Farm visits	7	37	25	68
(8)	Gardens/parks	7	37	18	49
(9)	Other	4	21	3	8

If (9), please give further details: ____________________

____

____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

TEACHERS QUESTIONNAIRE

WHOLE SAMPLE N= 269

Organisation

1. Is classwork in environmental science:

	No.	% response	
(1) A specified part of the curriculum	83	31	
(2) A planned part of broader topics	155	58	
(3) Developed as it arises	134	50	
(4) Not done	0	0	n=266

2. Is there:

(1) A scheme of work available	62	23	
(2) A set of broad guidelines	127	48	
(3) No general policy	91	34	n=266

3. What percentage of total lesson time is spent on environmental science activities?

(1) 0%	0	0	
(2) 5%	131	52	
(3) 10%	87	34	
(4) 15%	29	11	
(5) 20%	7	3	n=255

4. How would you describe the available first hand facilities of equipment and/or working areas for teaching environmental science?

(1) Poor	41	15	
(2) Less than adequate	94	35	
(3) Adequate	106	40	
(4) Good	20	8	
(5) Excellent	6	2	n=266

5. What, on average, is the size of group undertaking environmental sciences simultaneously?

(1) Less than 5	12	2	
(2) 6 - 10	34	13	
(3) 11 - 15	24	9	
(4) 16 - 20	23	9	
(5) 21 - 25	48	19	
(6) 26 - 30	58	22	
(7) 31+	68	26	n=260

./

6. Please rate the following aspects of environmental science education according to the importance you feel each should have for the children you teach:

Tick the age-group you teach:

L.I. U.I.	L.J. U.J.
95 38%	153 62%

The ability to:

	% response 1	2	3	4	5	6	Mean	S.D.
(1) Follow carefully instructions from a work card, book or blackboard	17	6	10	16	21	30	4.1	1.8
(2) Make notes of observations/results during the course of their work	16	8	8	14	22	32	4.17	1.82
(3) Make a satisfactory written record of work	11	7	14	18	26	24	4.13	1.63
(4) Decide the aspect of the topic they wish to study/investigate	15	12	25	30	13	5	3.29	1.39
(5) Choose what kind of record to make of their work	18	12	19	28	16	7	3.31	1.51
(6) Make careful, first hand observations	3	1	6	4	26	60	5.82	1.18
(7) Make drawings from first hand observations	3	3	11	14	28	41	4.84	1.31
(8) Write from first hand observations	8	3	9	18	26	36	4.58	1.53
(9) Design own experiments/investigations	18	11	17	24	19	11	3.49	1.6
(10) Identify the variables operating in certain situations	17	9	13	24	23	14	3.69	1.66
(11) Draw conclusions from results or make generalisations based on observations	6	3	7	16	32	36	4.73	1.39
(12) Use reference books for further information	7	4	6	18	20	45	4.77	1.49

7. Which of these do you consider to be the most important goals in environmental science?

Development of:

	1	2	3	4	5	6	Mean	S.D.
(1) Understanding of basic concepts such as habitat differences, living requirements, food webs etc.	1	3	5	17	28	46	5.06	1.14
(2) Problem solving skills	5	7	11	24	27	26	4.38	1.42
(3) The ability to carry out simple investigations/experiments carefully and safely	3	4	7	20	30	36	4.79	1.27
(4) The enjoyment of environmental activities	0	0	1	9	20	70	5.53	0.82
(5) A knowledge of the natural world around us	1	1	1	6	26	65	5.55	0.79
(6) The ability to observe carefully	1	0	0	6	22	71	5.61	0.75
(7) A questioning attitude towards surroundings	1	1	2	6	24	66	5.48	0.91
(8) A respect and appreciation of the natural world	1	0	1	4	18	76	5.66	0.75

	% response 1	2	3	4	5	6	Mean	S.D.
(9) The ability to find information from reference books	4	5	10	20	27	34	4.61	1.38
(10) The ability to use basic equipment safely and accurately	2	2	7	19	28	42	4.96	1.64
(11) Creative skills such as art, descriptive and imaginative writing, etc.	1	2	10	26	25	35	4.75	1.2

8. Which of these teaching schemes and materials are you familiar with?

Nuffield Science	10	26	33	21	6	4	2.99	1.2
Science 5/13	12	18	20	24	16	10	3.46	1.51

9. How much use do you make of T.V./radio programmes on environmental science?

	28	11	19	16	12	14	3.16	1.78

10. In what way would you like back-up resources from the L.E.A.?

(1) More courses to attend	6	7	18	24	18	27	4.22	1.5
(2) A greater availability of the advisory service	8	8	16	25	19	24	4.13	1.52
(3) A course based at your school	16	9	18	16	17	24	3.8	1.76
(4) More financial assistance	7	6	11	16	17	43	4.6	1.59
(5) Prepared guidelines in curriculum content	9	7	15	19	22	28	4.25	1.58
(6) Prepared guidelines for equipment buying	10	11	16	22	18	23	3.96	1.62

(7) Please state any other you feel important

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Personal Details

11.

	No.	% response	
Male	74	28	
Female	188	72	n=262

12. Graduate in:

	No.	% response	
(1) Environmental sciences	4	2	
(2) Biological sciences	3	1	
(3) Physical sciences	2	1	
(4) Other subject	59	22	n=265

(4)a. If B.Ed. please state main subject: (other than education) --------------

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n=265

		No.	% response
13.	Non-graduate, main subject:		
	(1) Environmental sciences	14	5
	(2) Biological sciences	12	4
	(3) Physical sciences	6	2
14.	Non-graduate:		
	(1) Some science but not main subject	72	27
	(2) Not trained in science	101	38
15.	Graduate or non-graduate, did you attend science-based curriculum courses?		
	(1) Environmental sciences	101	38
	(2) Biological sciences	29	11
	(3) Physical sciences	17	6
	(4) General science	85	32
	(5) None	89	34
16.	Were you primary or secondary trained?		
	(1) Primary	232	88
	(2) Secondary	51	19
17.	A-levels:		
	(1) Physics	7	3
	(2) Chemistry	13	5
	(3) Biology	17	7
	(4) Other science subject	28	11.
	If (4) please state details:		
18.	O-levels: (C.S.E.)		
	(1) Physics	49	18
	(2) Chemistry	58	22
	(3) Biology	121	46
	(4) Other science subject	66	25
	If (4) please state details:		

19. Have you ever attended a science-based course during your teaching career?

	No.	% response	
(1) Yes	149	57	
(2) No			n=260

If Yes - continue

If No - please go to question 21.

20. What has been your total involvement in science-based I.N.S.E.T. since 1st Sept. 1980?

(1) None	75	50	
(2) 1 - 6 hours	36	24	
(3) 7 - 15 hours	17	11	
(4) 16 - 30 hours	9	6	
(5) 1 - 2 weeks	7	5	
(6) 2 - 4 weeks	1	1	
(7) 4 weeks - 1 term	2	1	
(8) 1 term - 1 year	1	1	n=149

21. How many years teaching experience do you have?

(1) 0 - 5	26	10	
(2) 6 - 10	62	24	
(3) 11 - 20	103	40	
(4) 21 - 30	50	19	
(5) 31+	20	7	n=261

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

DIFFERENCES IN RESPONSE BETWEEN MEN AND WOMEN TEACHERS

6. Please rate the following aspects of environmental science education according to the importance you feel each should have for the children you teach:

Tick the age-group you teach:

	MEN I	MEN J	WOMEN I	WOMEN J
	0%	99.9%	41%	59%

The ability to:

	MEN No.	MEN Mean	MEN SD	WOMEN No.	WOMEN Mean	WOMEN SD
(1) Follow carefully instructions from a work card, book or blackboard	73	4.95	1.07	181	3.76	1.92
(2) Make notes of observations/results during the course of their work	73	5.18	0.91	184	3.77	1.91
(3) Make a satisfactory written record of work	73	4.84	0.95	182	3.82	1.74
(4) Decide the aspect of the topic they wish to study/investigate	72	3.56	1.16	181	3.16	1.47
(5) Choose what kind of record to make of their work	73	3.62	1.24	181	3.18	1.54
(6) Make careful, first hand observations	73	5.45	0.73	183	5.21	1.33
(7) Make drawings from first hand observations	73	5.01	0.96	185	4.76	1.43
(8) Write from first hand observations	73	5.0	0.93	182	4.45	1.68
(9) Design own experiments/investigations	73	4.05	1.44	181	3.25	1.62
(10) Identify the variables operating in certain situations	73	4.36	1.39	179	3.43	1.69
(11) Draw conclusions from results or make generalisations based on observations	73	5.01	0.97	183	4.6	1.52
(12) Use reference books for further information	73	5.08	0.99	184	4.63	1.65

7. Which of these do you consider to be the most important goals in environmental science?

Development of:

	MEN No.	MEN Mean	MEN SD	WOMEN No.	WOMEN Mean	WOMEN SD
(1) Understanding of basic concepts such as habitat differences, living requirements, food webs etc.	73	4.96	0.98	186	5.09	1.2
(2) Problem solving skills	74	4.66	1.05	182	4.26	1.52
(3) The ability to carry out simple investigations/experiments carefully and safely	74	4.91	1.04	186	4.76	1.36
(4) The enjoyment of environmental activities	74	5.23	0.88	188	5.66	0.77
(5) A knowledge of the natural world around us	74	5.14	0.82	188	5.68	0.74
(6) The ability to observe carefully	74	5.45	0.74	188	5.66	0.76
(7) A questioning attitude towards surroundings	74	5.39	0.86	188	5.53	0.92
(8) A respect and appreciation of the natural world	74	4.92	0.98	188	5.75	0.69

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	MEN			WOMEN		
	No.	Mean	SD	No.	Mean	S
(9) The ability to find information from reference books	73	4.86	1.02	185	4.52	1.5
(10) The ability to use basic equipment safely and accurately	73	4.44	1.09	183	5.01	1.1
(11) Creative skills such as art, descriptive and imaginative writing, etc.	73	3.04	1.13	184	4.88	1.2

8. Which of these teaching schemes and materials are you familiar with?

Nuffield Science	72	3.66	1.46	175	2.99	1.2
Science 5/13	70	3.03	1.56	175	3.41	1.5

9. How much use do you make of T.V./radio programmes on environmental science?

	71	3.3	1.56	183	3.25	1.5

10. In what way would you like back-up resources from the L.E.A.?

(1) More courses to attend	70	4.37	1.37	176	4.15	1.5
(2) A greater availability of the advisory service	71	4.17	1.41	175	4.11	1.5
(3) A course based at your school	70	3.74	1.64	168	3.87	1.8
(4) More financial assistance	71	4.55	1.65	176	4.64	1.5
(5) Prepared guidelines in curriculum content	69	4.1	1.44	179	4.31	1.6
(6) Prepared guidelines for equipment buying	69	3.58	1.46	175	4.1	1.6

(7) Please state any other you feel important

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Personal Details

11. Male 74 = 28%

Female 188 = 72%

12. Graduate in:

	MEN No.	%	WOMEN No.	%
(1) Environmental sciences	2	3	2	1
(2) Biological sciences	1	1	2	1
(3) Physical sciences	1	1	1	0
(4) Other subject	25	34	33	18

(4)a. If B.Ed. please state main subject: (other than education) --------------

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		MEN		WOMEN	
		No.	%	No.	%
13.	Non-graduate, main subject:				
	(1) Environmental sciences	3	4	11	6
	(2) Biological sciences	2	3	10	5
	(3) Physical sciences	4	5	2	1
14.	Non-graduate:				
	(1) Some science but not main subject	19	26	51	27
	(2) Not trained in science	18	24	83	44
15.	Graduate or non-graduate, did you attend science-based curriculum courses?	29	40	71	38
	(1) Environmental sciences	5	7	24	13
	(2) Biological sciences	8	11	9	5
	(3) Physical sciences	27	37	57	30
	(4) General science	21	29	66	35
	(5) None				
16.	Were you primary or secondary trained?				
	(1) Primary	60	81	170	90
	(2) Secondary	28	38	22	12
17.	A-levels:				
	(1) Physics	3	4	4	2
	(2) Chemistry	3	4	10	5
	(3) Biology	1	1	16	9
	(4) Other science subject	5	7	22	12
	If (4) please state details:				
18.	O-levels: (C.S.E.)				
	(1) Physics	25	34	23	12
	(2) Chemistry	23	31	34	18
	(3) Biology	17	23	101	54
	(4) Other science subject	15	20	50	27
	If (4) please state details:				

	MEN No.	MEN %	WOMEN No.	WOMEN %
19. Have you ever attended a science-based course during your teaching career?				
(1) Yes	49	66	98	53
(2) No				
If Yes - continue				
If No - please go to question 21.				
20. What has been your total involvement in science-based I.N.S.E.T. since 1st Sept. 1980?	n=49		n=98	
(1) None	14	19	60	32
(2) 1 - 6 hours	14	19	22	12
(3) 7 - 15 hours	7	9	10	5
(4) 16 - 30 hours	6	8	3	2
(5) 1 - 2 weeks	7	9	0	0
(6) 2 - 4 weeks	0	0	1	0
(7) 4 weeks - 1 term	0	0	1	1
(8) 1 term - 1 year	1	1	0	0
21. How many years teaching experience do you have?				
(1) 0 - 5	6	8	20	11
(2) 6 - 10	17	23	44	24
(3) 11 - 20	33	45	69	37
(4) 21 - 30	11	15	39	21
(5) 31+	7	9	13	7

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

TEACHERS QUESTIONNAIRE

DIFFERENCES IN RESPONSE BETWEEN INFANT AND JUNIOR TEACHERS

Organisation

	INFANTS No.	INFANTS %	JUNIORS No.	JUNIORS %
1. Is classwork in environmental science:	n=111		n=156	
(1) A specified part of the curriculum	31	28	52	33
(2) A planned part of broader topics	62	56	94	60
(3) Developed as it arises	66	59	68	44
(4) Not done	0	0	0	0
2. Is there:				
(1) A scheme of work available	28	25	32	21
(2) A set of broad guidelines	51	46	80	51
(3) No general policy	38	34	49	31
3. What percentage of total lesson time is spent on environmental science activities?	n=101		n=153	
(1) 0%	0	0	0	0
(2) 5%	50	50	80	52
(3) 10%	38	38	50	33
(4) 15%	9	9	18	12
(5) 20%	4	3	4	3
4. How would you describe the available first hand facilities of equipment and/or working areas for teaching environmental science?	n=111		n=152	
(1) Poor	12	11	29	19
(2) Less than adequate	36	32	54	35
(3) Adequate	51	46	59	38
(4) Good	9	8	13	8
(5) Excellent	3	3	2	1
5. What, on average, is the size of group undertaking environmental sciences simultaneously?	n=105		n=155	
(1) Less than 5	8	8	5	3
(2) 6 - 10	17	16	17	11
(3) 11 - 15	7	7	19	12
(4) 16 - 20	15	14	13	8
(5) 21 - 25	28	27	19	12
(6) 26 - 30	18	18	37	24
(7) 31+	13	12	57	33

6. Please rate the following aspects of environmental science education according to the importance you feel each should have for the children you teach:

The ability to:	INFANT Ni	Mean	SD	JUNIOR Nj	Mean	SD
(1) Follow carefully instructions from a work card, book or blackboard	107	2.92	1.81	154	4.87	1.25
(2) Make notes of observations/results during the course of their work	109	2.96	1.86	155	4.99	1.78
(3) Make a satisfactory written record of work	107	3.21	1.74	155	4.76	1.17
(4) Decide the aspect of the topic they wish to study/investigate	108	2.69	1.44	153	3.68	1.17
(5) Choose what kind of record to make of their work	108	2.74	1.54	154	3.73	1.39
(6) Make careful, first hand observations	111	5.04	1.46	154	5.48	0.89
(7) Make drawings from first hand observations	110	4.54	1.56	155	5.05	0.99
(8) Write from first hand observations	109	3.93	1.81	154	4.99	1.08
(9) Design own experiments/investigations	107	2.67	1.57	154	4.08	1.36
(10) Identify the variables operating in certain situations	107	2.84	1.63	151	4.26	1.35
(11) Draw conclusions from results or make generalisations based on observations	109	4.16	1.68	155	5.16	0.98
(12) Use reference books for further information	110	4.17	1.81	155	5.21	1.01

7. Which of these do you consider to be the most important goals in environmental science?

Development of:	Ni	Mean	SD	Nj	Mean	SD
(1) Understanding of basic concepts such as habitat differences, living requirements, food webs etc.	111	4.96	1.28	156	5.12	0.98
(2) Problem solving skills	107	3.97	1.6	157	4.67	1.17
(3) The ability to carry out simple investigations/experiments carefully and safely	111	4.43	1.51	157	5.04	0.97
(4) The enjoyment of environmental activities	113	5.66	0.85	157	5.45	0.79
(5) A knowledge of the natural world around us	113	5.66	0.82	157	5.42	0.76
(6) The ability to observe carefully	113	5.62	0.87	157	5.58	0.67
(7) A questioning attitude towards surroundings	113	5.48	1.06	157	5.47	0.76
(8) A respect and appreciation of the natural world	113	5.75	0.78	157	5.59	0.73

	INFANT Ni	Mean	SD	JUNIOR Nj	Mean	SD
(9) The ability to find information from reference books	109	4.21	1.66	157	5.07	0.99
(10) The ability to use basic equipment safely and accurately	107	4.8	1.36	157	4.6	1.1
(11) Creative skills such as art, descriptive and imaginative writing, etc.	108	4.95	1.3	157	5.53	0.78

8. Which of these teaching schemes and materials are you familiar with?

Nuffield Science	106	2.94	1.27	152	2.97	1.12
Science 5/13	106	3.38	1.53	150	3.46	1.46

9. How much use do you make of T.V./radio programmes on environmental science?

	109	2.86	1.77	154	3.29	1.75

10. In what way would you like back-up resources from the L.E.A.?

(1) More courses to attend	102	4.21	1.62	153	4.16	1.43
(2) A greater availability of the advisory service	103	4.1	1.59	151	4.07	1.48
(3) A course based at your school	100	3.72	1.8	148	3.89	1.73
(4) More financial assistance	102	4.51	1.58	151	4.59	1.65
(5) Prepared guidelines in curriculum content	105	4.37	1.59	152	4.13	1.55
(6) Prepared guidelines for equipment buying	102	4.05	1.58	151	3.9	1.61

(7) Please state any other you feel important

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Personal Details

11. Male

Female

12. Graduate in:

(1) Environmental sciences

(2) Biological sciences

(3) Physical sciences

(4) Other subject

(4)a. If B.Ed. please state main subject: (other than education) ----------------

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DIFFERENCES IN RESPONSE BETWEEN SCIENCE SPECIALIST AND NON-SPECIALIST TEACHERS

<u>Organisation</u>

	NON-SPECIALIST No.	NON-SPECIALIST % response	SPECIALIST No.	SPECIALIST % response
1. Is classwork in environmental science:				
(1) A specified part of the curriculum	39	25	12	48
(2) A planned part of broader topics	94	60	17	68
(3) Developed as it arises	81	52	14	56
(4) Not done	0	0	0	0
	n=156		n=25	
2. Is there:				
(1) A scheme of work available	34	22	7	28
(2) A set of broad guidelines	76	49	12	48
(3) No general policy	55	35	8	32
3. What percentage of total lesson time is spent on environmental science activities?				
(1) 0%	0	0	0	6
(2) 5%	76	52	10	40
(3) 10%	50	34	6	24
(4) 15%	14	10	8	32
(5) 20%	5	4	1	4
4. How would you describe the available first hand facilities of equipment and/or working areas for teaching environmental science?				
(1) Poor	26	17	4	16
(2) Less than adequate	49	31	7	28
(3) Adequate	64	41	11	44
(4) Good	14	9	2	8
(5) Excellent	3	2	1	4
5. What, on average, is the size of group undertaking environmental sciences simultaneously?				
(1) Less than 5	7	5	2	8
(2) 6 - 10	26	17	1	4
(3) 11 - 15	15	10	1	4
(4) 16 - 20	12	8	3	12
(5) 21 - 25	23	15	6	24
(6) 26 - 30	34	23	6	24
(7) 31+	40	26	6	24

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6. Please rate the following aspects of environmental science education according to the importance you feel each should have for the children you teach:

The ability to:	NON-SPECIALIST N	Mean	SD	SPECIALIST N	Mean	S
(1) Follow carefully instructions from a work card, book or blackboard	154	4.05	1.78	23	4.43	1.5
(2) Make notes of observations/results during the course of their work	154	4.14	1.88	24	4.42	1.4
(3) Make a satisfactory written record of work	154	3.97	1.66	24	4.5	1.0
(4) Decide the aspect of the topic they wish to study/investigate	152	3.16	1.37	24	3.5	1.5
(5) Choose what kind of record to make of their work	152	3.22	1.55	24	3.75	1.5
(6) Make careful, first hand observations	155	5.21	1.28	24	5.5	0.7
(7) Make drawings from first hand observations	155	4.83	1.32	24	4.96	0.9
(8) Write from first hand observations	152	4.46	1.63	24	4.83	1.1
(9) Design own experiments/investigations	152	3.43	1.65	24	4.17	1.6
(10) Identify the variables operating in certain situations	151	3.56	1.72	24	4.35	1.3
(11) Draw conclusions from results or make generalisations based on observations	153	4.77	1.44	24	4.83	1.3
(12) Use reference books for further information	155	4.6	1.59	24	5.16	0.9

7. Which of these do you consider to be the most important goals in environmental science?

Development of:	N	Mean	SD	N	Mean	S
(1) Understanding of basic concepts such as habitat differences, living requirements, food webs etc.	156	5.04	1.11	24	5.0	1.0
(2) Problem solving skills	152	4.46	1.4	25	4.76	1.1
(3) The ability to carry out simple investigations/experiments carefully and safely	155	4.74	1.26	25	5.16	0.94
(4) The enjoyment of environmental activities	157	5.55	0.67	25	5.56	0.82
(5) A knowledge of the natural world around us	157	5.56	0.64	25	5.36	0.81
(6) The ability to observe carefully	157	5.68	0.54	25	5.6	0.58
(7) A questioning attitude towards surroundings	157	5.55	0.8	25	5.44	0.76
(8) A respect and appreciation of the natural world	157	5.66	0.65	25	5.6	0.71

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	NON-SPECIALIST			SPECIALIST		
	No.	Mean	SD	No.	Mean	
(9) The ability to find information from reference books	157	4.51	1.42	25	4.68	1.
(10) The ability to use basic equipment safely and accurately	154	4.96	1.15	25	5.08	0.
(11) Creative skills such as art, descriptive and imaginative writing, etc.	152	4.81	1.15	25	4.68	1.

8. Which of these teaching schemes and materials are you familiar with?

Nuffield Science	153	2.9	1.22	25	3.04	1.
Science 5/13	150	3.42	1.48	25	3.92	1.

9. How much use do you make of T.V./radio programmes on environmental science?

	153	2.86	1.68	25	3.44	1.

10. In what way would you like back-up resources from the L.E.A.?

(1) More courses to attend	147	4.16	1.54	25	4.62	1.
(2) A greater availability of the advisory service	147	4.07	1.54	25	4.21	1.
(3) A course based at your school	145	3.88	1.76	22	4.09	1.
(4) More financial assistance	144	4.5	1.6	25	5.04	1.
(5) Prepared guidelines in curriculum content	148	4.37	1.25	23	3.74	1.
(6) Prepared guidelines for equipment buying	148	4.02	1.66	22	3.55	1.

(7) Please state any other you feel important

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Personal Details

11. Male

Female

12. Graduate in:

(1) Environmental sciences

(2) Biological sciences

(3) Physical sciences

(4) Other subject

(4)a. If B.Ed. please state main subject: (other than education) --------------

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TEACHERS QUESTIONNAIRE

DIFFERENCES DUE TO LENGTH OF SERVICE

Organisation

		>10 yrs n=88		<10 yrs n=173	
		No.	%	No.	%
1.	Is classwork in environmental science:				
	(1) A specified part of the curriculum	29	33	50	29
	(2) A planned part of broader topics	61	70	92	59
	(3) Developed as it arises	43	49	86	50
	(4) Not done	0	0	0	0
2.	Is there:				
	(1) A scheme of work available	18	21	42	25
	(2) A set of broad guidelines	39	49	85	50
	(3) No general policy	37	43	51	30
3.	What percentage of total lesson time is spent on environmental science activities?				
	(1) 0%	0	0	0	0
	(2) 5%	42	51	85	52
	(3) 10%	29	35	56	35
	(4) 15%	12	14	16	9
	(5) 20%	2	2	4	2
4.	How would you describe the available first hand facilities of equipment and/or working areas for teaching environmental science?				
	(1) Poor	12	14	28	16
	(2) Less than adequate	30	35	63	39
	(3) Adequate	35	40	66	39
	(4) Good	6	7	13	8
	(5) Excellent	4	5	2	1
5.	What, on average, is the size of group undertaking environmental sciences simultaneously?				
	(1) Less than 5	6	7	6	4
	(2) 6 - 10	11	13	22	13
	(3) 11 - 15	9	11	15	9
	(4) 16 - 20	7	8	14	8
	(5) 21 - 25	18	21	29	17
	(6) 26 - 30	15	18	42	25
	(7) 31+	21	25	44	26

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	>10 yrs N	>10 yrs Mean	>10 yrs SD	<10 yrs N	<10 yrs Mean	<10 yrs SD
(9) The ability to find information from reference books						
(10) The ability to use basic equipment safely and accurately						
(11) Creative skills such as art, descriptive and imaginative writing, etc..						
8. Which of these teaching schemes and materials are you familiar with?						
Nuffield Science	83	3.01	1.1	164	2.99	1.25
Science 5/13	85	3.79	1.48	160	3.31	1.5
9. How much use do you make of T.V./radio programmes on environmental science	88	3.22	1.75	165	3.17	1.78
10. In what way would you like back-up resources from the L.E.A.?						
(1) More courses to attend	86	4.55	1.47	159	4.09	1.48
(2) A greater availability of the advisory service	86	4.3	1.36	159	4. 09	1.5
(3) A course based at your school	84	4.15	1.59	153	3.71	1.78
(4) More financial assistance	84	4.74	1.45	162	4.57	1.62
(5) Prepared guidelines in curriculum content	85	4.36	1.48	162	4.25	1.61
(6) Prepared guidelines for equipment buying	85	4.11	1.46	158	3.91	1.7
(7) Please state any other you feel important						

- -

- -

Personal Details

		>10 yrs n=88 No.	>10 yrs n=88 %	<10 yrs n=173 No.	<10 yrs n=173 %
11.	Male	23	26	51	30
	Female	64	74	121	70
12. Graduate in:					
	(1) Environmental sciences	2	2	2	1
	(2) Biological sciences	2	2	1	0
	(3) Physical sciences	1	1	1	1
	(4) Other subject	31	33	27	16

(4)a. If B.Ed. please state main subject: (other than education) - - - - - - - - - - - - - -

./..

	>10 yrs No.	>10 yrs %	<10 yrs No.	<10 yrs %
13. Non-graduate, main subject:				
(1) Environmental sciences	5	6	8	5
(2) Biological sciences	2	2	10	6
(3) Physical sciences	2	2	4	2
14. Non-graduate:				
(1) Some science but not main subject	21	47	49	35
(2) Not trained in science	24	28	75	43
15. Graduate or non-graduate, did you attend science-based curriculum courses?				
(1) Environmental sciences	40	47	60	35
(2) Biological sciences	5	6	24	14
(3) Physical sciences	4	5	13	8
(4) General science	31	36	54	31
(5) None	28	33	58	34
16. Were you primary or secondary trained?				
(1) Primary	82	93	128	75
(2) Secondary	2	2	30	18
Mixed	5	5	15	7
17. A-levels:				
(1) Physics	2	2	5	9
(2) Chemistry	3	3	10	6
(3) Biology	3	3	14	8
(4) Other science subject	8	9	20	12
If (4) please state details:				
18. O-levels: (C.S.E.)				
(1) Physics	11	13	37	21
(2) Chemistry	15	17	42	24
(3) Biology	41	48	78	45
(4) Other science subject	24	28	41	24
If (4) please state details:				

		>10 yrs		<10 yrs	
		No.	%	No.	%
19.	Have you ever attended a science-based course during your teaching career?				
	(1) Yes	37	43	111	6[illegible]
	(2) No				

If Yes - continue

If No - please go to question 21.

		>10 yrs		<10 yrs	
20.	What has been your total involvement in science-based I.N.S.E.T. since 1st Sept. 1980?	n=37		n=111	
	(1) None	15	41	59	53
	(2) 1 - 6 hours	12	33	24	22
	(3) 7 - 15 hours	5	15	12	11
	(4) 16 - 30 hours	1	3	8	7
	(5) 1 - 2 weeks	2	6	5	5
	(6) 2 - 4 weeks	0	0	1	0
	(7) 4 weeks - 1 term	0	0	2	2
	(8) 1 term - 1 year	1	2	0	0

21. How many years teaching experience do you have?

(1) 0 - 5
(2) 6 - 10

(3) 11 - 20
(4) 21 - 30
(5) 31+

>10 yrs = 88 = 34%

<10 yrs = 173 = 56%

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

(xxx)

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