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ABSTRACT

This booklet provides an understanding of science education for young children in terms of both a theoretical basis for planning and a selection of practical experiences. The theoretical and practical sections are organized separately, and readers are advised that an understanding of the theoretical approach is essential prior to implementing the practical ideas. The theoretical section asks and explores the questions: What is science? Why teach science to young children? What are the aims of teaching science to young children? The next section gives practical advice on planning science experiences and on encouraging science experiences that are spontaneous and unplanned. The last section presents a selection of science topics as a stimulus and starting point for developing science with young children. Each topic addresses some basic concepts and includes relevant science information, practical comments, and suggestions for science experiences. The science topics presented are: animals, air, electricity, the human body and health, light, magnets, plants, sound, and water. Contains 17 references. (AS)

AUSTRALIAN EARLY CHILDHOOD RESOURCE BOOKLETS

SCIENCE FOR YOUNG CHILDREN

SUE ELLIOTT

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SCIENCE FOR YOUNG CHILDREN

SUE ELLIOTT

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INTRODUCTION

The aim of this booklet is to provide an understanding of science for young children in terms of both a theoretical basis for planning and a selection of practical experiences suitable for young children. For ease of reference, the theoretical and practical sections are organised separately, however, readers are advised that an understanding of the theoretical approach is essential prior to implementation of the practical ideas.

WHAT IS SCIENCE?

Perceptions of science may vary according to personal experience. For some people, science may conjure up images of white laboratory coats and bubbling test tubes, or it may suggest the somewhat remote and complex technologies of today such as genetic engineering and nuclear energy. However, to many people, science is a source of wonder and excitement and a means of exploring the challenging world in which we live.

It is this latter perception which has the most relevance to the teaching of science to young children. Children's natural curiosity leads to their eager exploration of the world about them. They are doing science during much of their play, usually without the inhibitions which adults may bring to the subject.

This perception of science is also analogous to the origins of science. Science began when humans made observations and experimented in order to understand their surroundings. Frequently this understanding was applied for the benefit of human kind. For example, observation of the relationship between the seasons and plant growth had application to agricultural practice. Therefore, just as science began many centuries ago, children are beginning science in an attempt to understand their surroundings.

Discussing perceptions of science provides some insight but does not adequately answer the original question 'What is Science?'. A definition most frequently stated (Primary Science Project Team, 1981; Trojcak, 1979) suggests that science as a subject is composed of two parts, the process and the product. The process is the actual experimentation which requires a variety of skills and attitudes such as observation, classification, prediction, problem solving and enquiry, while the product is the outcome of the experimentation, the concepts, principles, theories of science. Expressed more simply, the process is 'how' and the product 'what'. So, a child may experience the process of trying to attract a variety of materials with a magnet, before reaching the conclusion (or product) that only some types of materials are attracted by magnets.

Prior to the 1960s the emphasis in science teaching at all levels was on the product (Cain & Evans, 1984). This involved the rote learning of facts to be later tested. In more recent years, there has been a change to an emphasis on the process. This is clearly evidenced by the number of current science curricula ascribing to 'discovery learning', the 'hands on' approach and 'concrete experiences' (Balding & Richards, 1980; Harlan, 1984; Primary Science Project Team, 1981; Science Resource Units, 1982). The change in emphasis can be linked to the development of understanding about how children learn and their stages of cognitive development (Cain & Evans, 1984). The process emphasis utilises the natural curiosity and creativity children bring to science experiences, involves them in their own learning and encourages the development of skills and attitudes. The need for a process emphasis in teaching science is highlighted by the rapid rate at which science knowledge is changing. A child equipped with skills and attitudes rather than facts is more likely to succeed.

For young children science is primarily a process. A rewarding process that provides them with the skills and attitudes required for a lifetime of experimentation.

WHY TEACH SCIENCE TO YOUNG CHILDREN?

It is evident from the discussion of 'What is science?' that the natural curiosity of children and the process emphasis of science teaching today are a productive combination. What more could one want in a teaching situation than an explorative, eager child and interesting materials which can be manipulated?

Further support for teaching science is provided by Piaget's descriptions of the pre-operational stage child (2-7 years) whose cognitive level requires 'real' experiences for developmental progress (Abruscato, 1982; Cain & Evans, 1984; Carin & Sund, 1980). For example, the pre-operational child is unable to carry out mental operations such as grouping or ordering. Development of these operations can be encouraged by practical science experiences, e.g. grouping objects that float and objects that sink, grouping animals with fur, feather or scales, ordering the stages of seed development, or following the ordered stages of a simple experiment. The pre-operational child focusses on states rather than transformations and science can provide many practical transformation experiences, e.g. tadpole - frog, ice - water, wet - dry, to assist in this area. Animism is also a characteristic of the pre-operational child and science can provide rational explanations to encourage a more realistic view of the world.

The importance of these early science experiences and the appropriate language has recently been highlighted by Osborne and Freyberg (1985). Their research suggests that a child's understanding of science concepts and language begins well before any formal science teaching takes place. If the formal science teaching begins without taking into account the child's understanding, then conflicts may arise between what the child is taught and what he/she already understands from experience. Children may attempt to resolve this conflict in several ways:

1. Combining the teacher's and their own understanding to create an erroneous understanding.
2. Using the teacher's understanding at school and their own elsewhere.
3. Testing what they understand and what they are taught to arrive at the correct understanding.

Conflict and the risk of erroneous understandings could perhaps be avoided if early experiences nurtured the correct understandings and language and later teaching began by assessing the child's understanding.

From a broader perspective, Suzuki (1987) has recently commented on the need for scientific literacy and equates its importance with that of reading and writing. Scientific literacy is essential if people are to make informed and responsible decisions about issues of environmental concern. Hence, to teach young children science is an investment in the future.

The argument that science is 'too hard' for young children should be addressed. Some would suggest that the concepts are too abstract and the language too difficult. It is important to realise that in teaching science to young children one is aiming to provide a variety of 'real' experiences which will lay the foundation for the development of concepts. For example, after providing experiences with water painting, puddles, drying clothes and replenishing an aquarium accompanied by the word evaporation, a foundation has been laid for the development of the concept of evaporation. Do not hesitate to use the appropriate word. Children are very interested in words and the use of inappropriate words, e.g. disappear, vanish, can confuse later concept development.

Thus, from various perspectives it is evident that the teaching of science to young children is important not only for their own development, but for the future of the environment in which we live.

WHAT ARE THE AIMS OF TEACHING SCIENCE TO YOUNG CHILDREN?

This question has been answered in various ways by different authors. Macdonald Educational (1972) provides a flow chart outlining the aims of science education based on a primary aim of 'developing an enquiring mind and a scientific approach to problems'. Abruscato (1982) states general goals such as creativity, critical thinking, good citizenship and expanded career awareness supported by specific goals in the cognitive, affective and psychomotor domains. Carin and Sund (1980) list six objectives in the areas of knowledge, instrumental skill, science process, scientific attitude, appreciation and interest. The Science in the Primary School curricula (Primary Science Project Team, 1981) presents objectives in terms of attitudes, skills and concepts which may be developed through science.

While all of these suggestions are valid aims for teaching science, the latter is most useful when planning for young children. It is possible to list the attitudes, skills and concepts appropriate for young children, then select particular ones for a group or individual child and incorporate these as objectives when planning.

The following list indicates some of the attitudes, skills and concepts appropriate for young children which can be encouraged by science experiences.

Attitudes
- a positive, caring attitude to the physical and natural environment;
- a sense of enquiry;
- a willingness to manipulate, explore and investigate materials;
- an appreciation of the application and usefulness of science.

Skills
- observation
- classification
- problem solving
- prediction
- communication
- divergent thinking
- questioning
- experimentation

Concepts
- animals need food, a place to live and a mate
- air can push objects
- electricity flows in a circuit
- light is required to see
- water evaporates and condenses
- sound is created by vibrations

Although this list is not exhaustive, it does illustrate some of the aims of teaching science to young children. It should be noted that while other aspects of the curriculum may also contribute to the development in the areas listed, the purpose of this booklet is to realise the potenital of science. These aims are further discussed within the topic section of this booklet.

PLANNED SCIENCE EXPERIENCES

Convinced of the importance of teaching science to young children and the possible aims, the next step is to plan some science experiences.

1. Factors to consider

As is common practice when planning experiences for young children, the teacher should consider the needs and interests of the learner, the attitudes and role of other adults involved and the practicalities of the particular learning environment.

A factor for particular consideration when planning science experiences is the teacher's own attitudes, philosophy and ideas about science. Perhaps the most difficult point to come to terms with is that the teacher requires basic knowledge, but does not need to be a walking encyclopedia able to answer all questions (Walsh, 1984). An important part of science is the development of ways of finding out and the teacher should work through these processes as a facilitator with the child. Also, it may be useful for the teacher to attempt an objective assessment of his/her own science interests. For example, if a teacher is absolutely negative about earthworms, one cannot expect much positive teaching to flow from a child's interest in earthworms. To be aware of such biases is a beginning and the next step is to attempt to redress them.

2. Formulating Objectives

After considering these factors and determining which are most influential in the particular learning situation, the teacher is ready to develop objectives. It is not the purpose of this section to provide instruction in the development of objectives, but to highlight points relevant to the development of science objectives.

Firstly, to return to earlier comments it must be remembered that science learning experiences are not just about science concepts, e.g. insects have six legs. Objectives relating to the development of science attitudes and skills are equally, if not more important.

Secondly, when developing science objectives over a period of time it is essential to provide some sequence or balance to the learning promoted. To return to the insect example, to identify insects by leg number, a child would need to be able to closely observe insects and other animals. Such observation would require a positive attitude to animals, perhaps the skill of using a magnifying glass, an ability to identify legs and an ability to count. Once able to identify insects by leg number it may be appropriate to investigate other characteristics used in animal identification or perhaps the variety of leg types.

Thirdly, it should be noted that objectives related to other aspects of the child's development may be achieved through science. For example, objectives concerning co-operative play, independence, persistence, manipulative skills and communication skills are possible.

3. Selecting Learning Experiences

Once objectives are formulated, it is possible to select appropriate learning experiences. At this stage a variety of resources can be employed. As commented earlier, a range of science curricula based on the process approach have been developed. Although most are directed towards the primary teaching level, they provide a major resource of science learning experiences. The curricula vary considerably in their organisation, some based on science topics (Science Resource Units, 1982; i.e. Macdonald Educational, 1978), some based on skills and concepts (Primary Science Project Team, 1981) and some arranged in year levels (Dale, 1986; Balding & Richards, 1980). Depending on the objectives the teacher wishes to fulfill, one type of organisation may be more useful than another. A list of curricula and other relevant references can be found in the Reference section.

One should also explore the local area for resources. Often museums, zoos, parks, etc., publish a range of materials which can be adapted to provide science experiences. Also, talking to other people working with young children and using one's own imagination can provide a resource.

4. Implementation

Implementation of the selected learning experience in the particular programme is the next stage.

Apart from general considerations such as group size, space, likely difficulties or questions, need for supervision, one should pay particular attention to the arrangement of materials. Arrange the materials in a way which will invite children to explore and promote achievement of the objective. Aim to avoid the disorganised clutter which can occur when too many or too great a variety of materials are presented.

In a more practical sense the materials available need to be considered. Many 'science' materials can be easily found in the home, e.g. funnels, plastic bottles, rubber bands, torches, or the supermarket e.g. balloons, straws, candles and seeds. Recycled materials, e.g. milk cartons, paper, boxes, spools and plastic containers, are also useful. Some materials are specialised, e.g. magnets, aquaria, magnifying glasses and it is worthwhile to purchase good quality specialised materials from hardware shops, pet shops or scientific suppliers. Don't forget the natural and physical environment which can provide a range of materials, e.g. bark, leaves, snails, rocks, soil, puddles, for use in situ or on loan.

5. Evaluation

Evaluation is an essential aspect of planning learning experiences. The experimental nature of science experiences ensures that there will be some apparently negative outcomes. These can be a source of valuable learning and should not be discarded as failed science experiences. For example, a chicken that did not hatch may be a great disappointment, but children could hypothesize about why it failed to hatch, suggest what should be done with it and communicate how they feel about the situation — all of which are valuable learning experiences.

UNPLANNED SCIENCE EXPERIENCES

In the preceding paragraphs an approach to planning science for young children has been described. While planning ensures that some science experiences occur, it should be noted that much valuable science can occur in an informal or spontaneous way. Many of the experiences normally provided for children's play such as water, sand, clay, cooking, painting, pasting and blocks can be seen through 'science coloured glasses'. For example, playing with clay may promote discussion about the source of clay, how it is different from other soils, why water is added to clay, how soft clay can be made into hard pottery etc. In scientific terms, aspects of geology, the water cycle and the effects of heat have been discussed.

Accessories added to play may also promote unplanned science experiences. For example, scallop shells at dough play, smooth rocks at the sand pit, gum nuts for pretend food at dramatic play and plant weeds in water trough. Although not the focal point of the play, the accessories suggested above may encourage sensory appreciation, divergent thinking, concept development, experimentation, all aspects of science learning.

In addition, experiences quite unrelated to the planned program may provide opportunities for science. For example, a rainbow, a trail of ants, a flowering plant or news items brought from home. One day a dead bird found in a playground led to detailed observation, hypothesizing about the causes of death, communication about what to do with the bird and even predictions about what would happen to the bird in the ground. Also, language development, safety, co-operation and physical skills were involved. How much learning would have been lost if the bird had been tidily removed prior to the children arriving?

Unplanned science experiences are only limited by the teacher. With some basic science knowledge and resources, interest and imagination, the possibilities are endless.

SCIENCE TOPICS

The latter section of this booklet provides a selection of science topics often explored with young children. Each topic addresses some basic concepts and includes relevant science information, practical comments and suggestions for science experiences. The topics are presented as a stimulus and starting point for developing science with young children.

1. Animals

Animals have traditionally been discussed with young children in groupings such as farm animals, zoo animals and animal pets, and to a large extent the focus has been on the larger mammals. The increasing range of publications about animals for children suggest that this traditional approach is fading. Australian native animals are very much in vogue as part of our natural heritage, small garden creatures are worthy of investigation and environmental educationalists are encouraging a more responsible and caring attitude to animals in the environment.

To further assist a move away from traditional approaches, the following concepts and experiences are provided as a basis for planning and learning about animals.

(i) *Animals have needs — a place to live, food and a mate*

A variety of first hand experiences can be provided to encourage development of the concept that animals need a place to live. One could begin by looking for animals, or evidence of animals in the playgound and discussing where they are found, e.g. slaters under rocks and leaf litter, birds in trees, caterpillar chewed leaves, spider webs, worm castings on wet ground. Animals vary considerably in the type of place they need to live and this can often be related to characteristics of the animal. For example, earthworms are light sensitive therefore live underground avoiding sunburn and predation, the shape and colour of stick insects provides camouflage and the webbing of a platypus' foot aids swimming. Discussion with children is likely to raise a range of ideas about the relationship between animals and their habitat. Remember that all ideas are worthy of recognition, even if scientifically incorrect, because an important part of the science process is the development of creative and divergent thinking.

These observations and discussions could be extended further with the following practical experiences:

- A large poster of a forest, river or tree with small pictures of animals for the children to attach in the appropriate habitat for the animal.
- A water trough or sand tray containing small plastic or wooden animals and a range of natural materials, e.g. logs, bark, leaves, shells, rocks, for children to create animal habitats.
- Construction and/or arrangement of places for animals to live on a short-term basis, e.g. insect cage, chicken brooder, aquarium, bird nesting box or hollow.
- Cardboard box tunnels, perhaps leading to a cubby, to encourage dramatic exploration of the places where wombats, platypuses, ants or earthworms live.

Children can readily relate to the animals' need for food. The following questions could be used to promote discussion:

What food could they eat? How might they find food? e.g. sensory detection, stalking, lying in wait, chasing. I wonder how they eat? e.g. limbs and/or claws to hold food, teeth to grind or tear food. Even what comes out the other end may be of interest. Try observing bird, caterpillar or snail droppings.

Practical experiences related to the above might include:

- Keeping an animal and providing the appropriate food(s), possibly experimenting to determine which food an animal prefers.
- Making seed and dripping puddings or feeding trays for birds remembering to discuss safe locations for them.
- Examination of animal skulls with various teeth types.
- Providing an animal lunch which is edible for children, e.g. a snail lunch of lettuce leaves, a possum lunch of fruit, a rabbit lunch of carrots and celery. Use your imagination!
- Experiment with droppings by providing snails with lettuce for a few days, then rolled oats moistened with water, note the changes.

The animal need for a mate introduces concepts about sexual reproduction, birth, rearing of young and the cycle of life. It can also be extended to consider the ways in which animals live individually, e.g. wombat; in family groups e.g. kookaburras; in large groups e.g. kangaroos; or highly structured groups e.g. ants.

Practical experiences could include:

- Hatching and rearing chickens.
- Keeping a male and female of a particular species for breeding, e.g. guinea pigs, rabbits, mice, budgerigars.
- Collecting eggs from the playground for short-term keeping and hatching, e.g. snail eggs, butterfly eggs, spider egg cases.
- Collecting frogs' eggs and observing the transformation to adult frogs.
- Constructing an ant farm.

(ii) *Animal structures relate to functions*

Discussion of this concept encourages children to think about why animals are like they are, rather than to accept the structural features of animals at face value. Such thinking can be creative and divergent, as well as contributing to children's appreciation of the variety of animal forms. The structure and function of animals can be related in many ways, the functions of protection, movement and feeding are perhaps most easily understood by young children.

One could discuss the various structures that animals use to protect themselves, e.g. spines of an echidna, pincers of earwigs, poison fangs of snakes, and how children choose to protect themselves. A less obvious form of protection, which would require close observation, is camouflage.

Some animals can move quickly, e.g. kangaroo, centipede, some animals move slowly, e.g. millipede, elephant, while others have specific structural features which allow them to move in particular habitats, e.g. fish have fins to swim, koalas have sharp claws to climb, some monkeys have pre-hensile tails to swing from tree to tree. These features could be noted while observing particular animals or discussing appropriate pictures, or translated into movement experiences.

The type of food animals feed on can be directly related to mouth-part structures. Birds alone, vary considerably in their beak shape from the solid, curved beaks of seed eating parrots to the fine long beaks of nectar-eating honeyeaters. Direct observations of animals feeding, picture discussions and matching card games of animals and food types could be used to develop this concept.

2. Air

Air is a difficult topic for young children to understand because air itself is not observable. Air is understood by its effects. The following paragraphs indicate ways in which some concepts about air might be explored with young children.

(i) *Air is all around us*
Children could explore this concept by feeling the air when waving their arms, running to feel the air rush past their bodies or fanning themselves.

(ii) *Air can push objects*

Air which is moving, i.e. wind, can push objects ranging from yachts, windmills, trees to leaves, winged seeds and sand. These observations could be made outdoors in the playground or discussed with pictures. Children can also gain direct experience of this concept by blowing, blowing through straws or squeezing empty plastic bottles to push objects such as leaves, feathers, buttons, beads, corks, cotton reels or crushed paper balls. One type of object may be sufficient to initiate the experience and to allow children to develop an understanding of the concept and the skills necessary to direct air flow. Extension with other types of objects would encourage comparison of objects easily pushed and those not so easily pushed, and the factors involved, e.g. weight, shape, surface. Also, children could be asked to make predictions about particular objects before testing, then classify the object according to the results.

Blow painting could be a further extension of this experimentation. Provide two pots of paint of the same colour, but different consistencies. Children place a spoonful of each on a sheet of paper, then use a straw to blow the paint across the paper.

Two health and safety points to note with the above experiences are firstly, the provision of one straw per child to prevent cross-infection and secondly, the avoidance of objects too difficult to blow which may promote problems associated with breathing, e.g. asthma, hyperventilation.

(iii) *Air occupies space*

Two simple ways of exploring this concept include blowing through a straw or pushing in a syringe plunger (no needle) with a finger placed over the end. Questions such as: 'What is inside the straw/syringe?'; 'Why can't the plunger be pushed all the way in?', can be used to promote the concept that air occupies space.

Another way to demonstrate this concept, which is perhaps more likely to encourage explanations of 'magic' from children, is inverting a clear plastic cup into a clear sided container of water. The inside of the glass remains dry because the air occupying the space in the glass prevents the water from entering. Tipping the inverted glass a little will allow bubbles of air to escape and water to enter.

Observation of a variety of everyday materials can also reveal that air occupies space. Balloons, inflated paper bags, tyres, lilos, inflated swimming pools, bubbles, bread, cake, beaten egg whites, even Swiss cheese, all contain air and are within the range of a child's experience. Actual practice beating soap flakes in warm water, blowing up paper bags or pumping up tyres could also encourage comments about changes in shape and volume which occur when air is added and the different ways in which air can be added.

It should be noted that this concept also has implications for the teaching of the concepts empty and full. Care needs to be taken to specify the substance involved, since a bottle may be regarded as full of air but empty of water.

3. Electricity

Electricity is a science topic which is frequently avoided with young children. Perhaps it is believed to be unsafe, or perhaps teachers lack confidence and knowledge in this particular topic. Apart from providing many 'hands on' experiences, the topic of electricity can assist in promotion of the attitude that science is useful and can be applied.

(i) *Electricity can be used to do things*

Children are likely to have many ideas about the objects in their home which require electricity. From an environmental education perspective it may also be useful to pursue those things which could be done manually without electricity, e.g. beating cakes, drying hair, shaving, drying clothes.

Practical experiences planned for young children might include the use of heating or cooling fans, hairdryers, lights, mixers or blenders. Adult supervision is essential for these experiences and safety knowledge is to be encouraged.

(ii) *Electricity flows in a circuit*

This can be a difficult concept to grasp and is best introduced by providing a battery, light bulb and wires for experimentation. Trial and error experimentation, with guidance if required, eventually leads to the success of a glowing bulb. At this point children could be asked to trace around the circuit to show how everything is joined and to highlight the continuous nature of a circuit. Also, breaking the circuit at different points reinforces the need for a circuit to make the globe glow. Depending on the interest level, it may be appropriate to introduce a switch, another way of breaking and joining a circuit.

(iii) *Some materials conduct electricity*

Once the concept of a circuit is established, children can experiment further by introducing various materials, e.g. nails, paper, alfoil, wool, cloth, spoons, into a section of the circuit. If the globe in the circuit glows, then the material is conducting electricity.

4. The Human Body and Health

Children are fascinated by their own bodies. Body awareness experiences including creative movement, finger plays and drawing body outlines, are only the beginning in the exploration of the human body.

(i) *Human bodies are different*

A sense of individuality and an understanding of similarities and differences can be developed by comparing features of the human body. Features to consider might include hair type, eye colour, skin colour and genitals. It may also be appropriate to consider height and weight, features which change over time. Apart from direct observation, an understanding of these features could be developed with felt or cardboard cut-outs. The cut-outs could be mixed and matched according to the type of body the child wishes to create. Variety among the dolls provided for imaginative play could also promote discussion.

(ii) *Human body structures are related to their functions*

Beyond the obvious legs, arms, eyes, noses etc., children can develop an understanding of the skeleton, muscles and some internal organs. The skeleton can be simply explored by feeling the body's bones and discussing what the body would be like without bones. Follow up with x-rays, a mini-skeleton or animal bones could be useful. Children are usually very willing to demonstrate their muscles carrying blocks, climbing and jumping. The control and strength of small muscles could be highlighted when children are engaged in fine, manipulative work.

Internal organs such as the heart, lungs and stomach are most easily discussed in relation to their specific function. Practical experiences might include:

- Feeling a pounding heart or listening with a stethoscope.
- Taking deep breaths, going for a run or watching breath condense on cold days.
- Listening to stomach noises.

(iii) *The human body requires maintenance*

Current trends towards a healthier lifestyle and preventative medicine can be incorporated into planning for young children. Play about doctors has a long-standing tradition in the teaching of young children and such play is very useful in helping children to understand the doctor's role and to express their feelings. However, an emphasis on prevention rather than promoting the attitude that the doctor will 'make it better' is appropriate today. To develop healthy habits and attitudes in young children is far easier than persuading adults to change their lifestyle.

Discussing the food we eat can go beyond classifying those that are 'bad' for you and those that are 'good'. Consider the role of various types in growth and development, e.g. dairy products for bones, fruit and vegetables fibre to aid digestion. Food types could be discussed with pictures and practical experiences provided by cooking, lunch days and healthy parties.

It may be appropriate to discuss exercise as a part of body maintenance. Children may be aware of parents exercising and could discuss the value and types of exercise and what they like to do.

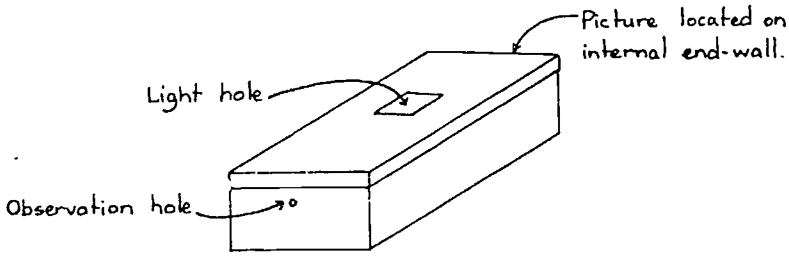
5. Light

Like air, light is an aspect of the environment which is often taken for granted, yet for young children it can be a rewarding topic for exploration.

(i) *Light is required to see*

'Light is required to see' is a basic concept to begin an exploration of light. Children will often have their own experiences of light and dark to contribute to discussion, e.g. bedrooms at night, camping in the bush. These could be extended by the following practical experiences:

- A dark cubby made from a card table covered with a blanket and two small torches.
- A light and dark box made from a shoe box, cover and uncover the light hole with one hand while looking through the observation hole. (Refer diagram p.12)



(ii) *There are many sources of light*

The sun can be discussed as the major source of light and variations in sunlight intensity can be noted when a cloud passes in front of the sun. It's important to remember that the sun doesn't go behind a cloud, which is a common explanation, but misleading for children in terms of science understanding.

Other sources of light such as electric lights, candles, torches and bicycle lights could also be explored through discussion or practical example. Further extension might include discussion of the use of lights for safety, e.g. traffic lights, ambulance lights and lighthouses. These examples could be incorporated into imaginative play or provide an application for a simple electrical circuit.

(iii) *Objects in light can create shadows*

The understanding of shadows and how they are created can be difficult for young children. Often the shadow is seen as an entity in itself, rather than the result of a particular set of circumstances, i.e. an object blocking the path of light. An understanding of shadows may begin with informal observations outside on a sunny day. Observe the objects and people and the shadows they make. Also, try changing the shadows to establish the relationship between the object and its shadow. Indoors shadows can be explored further in the following ways:

- A screen and slide projector for whole body shadows.
- Several torches and a dark cubby made from a card table covered with a white sheet then a blanket creates a secret place for shadow making.
- A small lamp and a shadow screen made from a cardboard box frame and white cloth can be used for finger play shadows, guessing objects by their shadow or shadow puppets.

6. Magnets

Magnets can be interesting objects for children to experiment with, but very frustrating if they are only weakly magnetic. Magnetic attraction occurs as a result of the alignment of molecules within a magnet. If this alignment is disrupted then the magnet will weaken. To maintain strong magnets ensure that they are not dropped, place keepers on the ends of the magnet and store them in a separate container away from objects attracted by magnets. If a magnet does weaken it may be possible to re-magnetise by stroking a strong magnet along the length of the weaker one. This realigns the molecules.

(i) *Magnets attract some objects and not others*
A common misunderstanding about magnets is that they attract objects made of metal. Provide children with a range of metal and non-metal objects and they will soon find that some metals are not attracted. Only objects made of iron or steel are attracted by magnets. This observation can be applied to 'treasure hunt' games where children attempt to locate objects buried in sawdust or wooashavings with a magnet.

(ii) *Magnets can attract objects through other materials*
Not only do magnets attract objects when in direct contact, but magnets can attract through various materials. Provide children with a magnet, an object attracted by a magnet and various materials to test, e.g. paper, cloth, plastic, metal, cardboard. This experimentation could be extended by folding the materials to determine if thickness of the material influences magnetic attraction. The ability of magnets to attract through materials can be applied in the following experiences:

- Hide an object under a cloth, or in one of several envelopes or b' xes, then find the object with a magnet.
- A magnetic story board can be made from a box with a background scene pasted or drawn on the base, a selection of magazine cut-outs of people or animals with paper clips attached and a magnet.
- A magnetic puppet show can be made from a box placed on its side and cork puppets with a nail or drawing pin in the base. The magnet is used to move the puppets from underneath the box stage.

7. Plants

Plants are a very important part of the environment and experiences for children can be extended beyond the usual carrot tops and wheat seeds.

(i) *Plants need sunlight and water to grow*
The two factors sunlight and water provide opportunity for direct experimentation with growing plants. What happens if a pot plant is placed in a dark cupboard? What happens if a pot plant is not watered? A common mistake in the presentation of this concept is to use seeds, rather than grown plants. Seeds placed in the dark will actually germinate more readily and grow more quickly than seeds placed in the light. The solution to this apparent dilemma lies in thinking about the conditions under which seeds normally germinate. Is it dark or light in the soil?

Practical experience with plant needs could also be provided by children planting their own seeds and caring for growing plants. Discussion about the needs of plants might arise informally when plants are watered in summer, or when outdoor equipment is moved and the yellowed grass underneath is an obvious sign of lack of sunlight.

(ii) *Seeds have particular characteristics*

A mixture of large seeds, pebbles, buttons, beads etc. for sorting may provide an interesting starting point for a discussion about seeds. Ask the children to find the seeds and encourage description of the characteristics of seeds. If there are any items the children are unsure about ask for suggestions as to how they could find out whether or not they are seeds. A simple solution is to try growing them.

Seeds consist of a plant embryo, food for the plant embryo and a protective seed coat. These parts are best observed by soaking a broad bean seed overnight, then cutting it in half lengthways. The plant embryo will be very small and attached to the inner wall of the seed, the rest of the seed is the food store. Although visible with the eye, a magnifying glass is helpful.

(iii) *Seeds can be planted to grow*

When planting seeds with children the actual process of seed germination can provide valuable experiences with growth, change and sequencing. Recording the days of growth and changes observed, or making a sequence of drawings on cardboard squares can highlight these experiences.

A useful way to germinate seeds to illustrate seed development involves placing pea or bean seeds on a piece of paper towel. Layer the paper towel onto a piece of plastic wrap, then roll up and secure at each end with a rubber band to form a bon-bon shape. Place one end of the bon-bon in a jar containing a few centimetres of water. The water will be absorbed by the paper and the seeds will germinate over a week or two. The seeds can be unwrapped daily to observe the stages of seed development. Ensure that a dry seed is kept for size comparison and note in particular whether the root or shoot emerges first and the direction of growth.

Planting the seedlings in individual pots or a garden could be a further extension to introduce the concept that particular seeds grow into particular types of plants, e.g. pea seeds grow into pea plants. However, it can be confusing when acorns grow into oak trees!

8. Sound

Sound as a science topic can be explored in conjunction with the development of listening skills and musical appreciation.

(i) *Sound is created by vibrations*

Sound itself consists of vibrations and we hear sound because our ears are sensitive to the sound waves produced by the vibrations. Practical experiences to develop an understanding of the relationship between sound and vibration include:

- Place a hand over a speaker to feel the vibrations.
- Speak through a rolled sheet of paper and feel the vibrations of the paper.
- Pluck a taut rubber band and observe the vibrations.
- Strike a tuning fork, then place it against a hand.

These observations could be extended to musical instruments and the vibrating part of the instrument investigated, e.g. guitar strings, drum surface. If drum vibration is difficult to observe try placing some small buttons or beads, or pieces of paper on the drum surface.

(ii) *The pitch of sound can vary*

The pitch of a particular sound varies according to the amount of material which is being vibrated. Hence, a bottle full of water will have a lower pitch than a bottle containing a little water. The reason being that the large amount of water to be vibrated slows down the rate of vibration and the slow sound waves produced are detected as low pitched sound.

When presenting this experience avoid using coloured water in the bottle. Although it may look effective, the colour can be a distraction from the correct reason for the variation in pitch. The relationship between the amount of material vibrating and the pitch can be reinforced with a range of experiences:

- A range of nail sizes hung from a rod for playing.
- Rubber bands of varying thickness stretched over a box for plucking.
- A glockenspeil with bars of varying sizes.
- A guitar with strings of varying thickness.

9. Water

Water in its natural form, not coloured, can provide a science learning resource alone or can be used with other materials such as sand, soap or gravel. Exploration of water could begin with some simple questions about a bucket of water. Compare the weight of a bucket full of water and an empty bucket. Which is heavier? Can the bottom of the bucket be seen? What does water smell like? Taste like?

(i) *Water flows*

Tip over a bucket of water and it is obvious that water flows. Whether simply pouring in a water trough or creating rivers in a sand pit, water will always flow to the lowest point. The flow of water creates a force which can turn water wheels, erode sand tunnels or carry along boats, leaves etc. A challenge to stop the flow of water could present opportunities for problem solving and understanding of the force involved. Using a clear plastic length of hose to siphon could extend this concept further and also, introduce the effects of air pressure.

(ii) *Water evaporates and condenses*

The various forms of water, e.g. water, vapour, rain, dew, clouds, and the changes from one form to another are the basis of the water cycle. While an understanding of the water cycle is probably beyond young children, there are many ways of providing experience with the forms of water and the change process.

Condensation occurs when the small unobservable droplets of water vapour in the air coalesce in response to a reduction in temperature. The larger water droplets which form are visible. Condensation can be observed on windows on cold mornings, as clouds in the sky, by blowing on a mirror or as drips on a climbing frame.

The reverse process occurs when water evaporates to form water vapour. Children readily observe evaporation when puddles or their water paintings apparently disappear. When questioned, a frequent and quite logical response is that the water has soaked into the ground or object painted, just as a sponge soaks up spilt drinks.

Evaporation from an aquarium is perhaps not so easily explained! Providing a variety of experiences for children to test their understanding and introducing the terms evaporation, condensation and water vapour will help children to develop the correct understanding.

(iii) *Water can be a solid or a liquid*

Changing water to ice and back again provides opportunities to experience change, explore the properties of ice and water, make predictions and solve problems. For example, the initial problem might be how to change some water into ice? What appliance is necessary? Does the water need to be placed in a container? Why? How long will it take to change? Once the ice has been formed explore its sensory qualities. How does it feel, taste, smell? What shape is it? What is likely to happen to the ice? How could the melting process be speeded up or slowed down? How long will it take to melt?

This experience could be followed through with individual ice blocks in named plastic bowls, so each interested child has an opportunity to take responsibility and act independently.

Freezing some small plastic objects or buttons in the water provides some interesting observations. Although the objects can be seen in the ice, just as in water, they cannot be retrieved until the ice melts. Ice blocks could be added to water troughs on warm days to provide further melting experiences.

CONCLUSION

Science is an important part of a young child's life. It provides a way of finding out, a way of thinking and knowledge about the world. The role of care-givers, parents and educators is to realise the potential of science and facilitate, both formally and informally children's science learning.

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