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INTRODUCTION

This chapter is a case study of a class of Year 5 students who investigated animals they found in their school environment. In this particular curriculum unit, science and technology are linked in a symbiotic way, that is, they depend on each other. Before the children could conduct their scientific investigations they had to design and make technological products for the specific purpose of collecting and housing the animals to be studied.

Embedded in this story you will find ways of addressing the following issues of concern to primary teachers:

- putting constructivist teaching and learning theories into practice
- planning learning experiences within a meaningful context
- linking several key learning areas
- making use of limited resources
- selecting assessment strategies, including portfolios.

The children shaped the story because they had ownership of their work. Wendy, co-author and teacher, said:

My aims for this unit of work were to have the children looking at their school environment and becoming aware that there are a lot of elements to that school environment. You’ve got your trees and shrubs, but on and under and perhaps even within the bark of those trees and shrubs you’ve got animals and they make up a whole ecosystem. In order to study those, the children were needing to find some way of capturing the small animal they wanted to study further, and then, through asking and posing their own questions, finding out more about that animal and having a very much child-centred unit of work so the children feel that they had ownership of what they were doing. The children come up with the design for the enclosure they’re going to put the animal into, they design how they are going to catch that animal, they pose the questions that they’re interested in finding out about that particular animal.
Participation in the unit encouraged the students to value their natural environment, take responsibility for elements of their learning, work cooperatively and to communicate orally as well as in written form. The timeframe for the unit was eight weeks, with sessions of one and a half hours per week.

Taking account of prior knowledge

As highlighted in other chapters, the ideas students bring to the classroom affect how and what they learn. When planning the unit Wendy took the students' prior knowledge into account by finding out what the students had done before, in earlier years at school and drawing on her own past experiences with these students. She began the unit with the students revisiting trees and shrubs that they had studied earlier in the year. Wendy recalls:

Before the children went and designed their bug catcher and their bug enclosure we revisited some work that we did earlier in the year when we took a broad look at the school environment, and in the first session we went out and looked at the trees and shrubs within the school, having one tree or shrub for each group. The children selected it and they were really observing textures, leaf shapes, posing questions as to what advantage to the tree it might be to have that type of bark, whether it was going to give protection from insect attack or even the climatic conditions. You are really building up that spirit of enquiry and questioning and that leads naturally into looking at the creatures found in and around it, and the sorts of questions you could generate for yourself from observing those and wondering what they are and how they live, even how they reproduce.

This introductory activity that Wendy described was important because it encouraged students to link new knowledge with their existing knowledge (Driver & Bell 1986; Hand & Prain 1995).

Students observing and recording

In order to develop their observation skills Wendy required the students to reexamine their trees and shrubs and search for animals living on or around these plants. Wendy introduced the activity using focus questions.

Are different-shaped leaves on the plant?
Are they adult or juvenile leaves?
Can you suggest reasons for any differences? For example, how could the leaves help the plant?
Closely examine a leaf from your plant. What is its shape, size and texture? What are the advantages for the plant of having these particular leaves?
Look at the colour and texture of the bark. What is its function?
Find out the name of your plant. What are its origins and the ideal growing conditions for your plant? You could think up an experiment.
Consider the trees as part of an ecosystem. How might you present the information about the animals on and under your plant?
Magnifying glasses were available for students to help them examine the leaves more closely. After the class had observed their trees and surrounds students shared the observations they had recorded. For example, Lisa reported that she had noticed different coloured leaves on her tree. The leaves in the sun were green, whereas those in the shade were brown. Lisa also observed that the juvenile leaves were shaped differently from the more mature leaves.

FIGURE 6.1 Mature and juvenile leaves on Lisa's tree

Some schools may have access to equipment, such as digital cameras and microscopes, including a computer microscope (for example, Intel). Students can take digital photographs to record features like those noted by Lisa. These photographs can then be inserted in students' written work. The computer microscope can be used in the same way.

Teacher posing questions

As facilitators teachers can aim to capitalise on reporting back to the class sessions by initiating questions designed to extend the students' ideas. Think of some questions related to Lisa's observations that would help develop students' understanding of what is required for plants to make their own food. Would you introduce the process of photosynthesis here? Why?
Making links with the English literacy area

The middle years of schooling, encompassing the final two years of primary school and the first two or three years of secondary school, are when many students lose interest in school and question the relevance of what is taught. Some departments of education are investing considerable resources to run professional development courses to address the problems of student engagement and learning in the middle years. For example, literacy skills can be developed more effectively through teaching skills in relevant contexts. Science and Technology can provide the opportunity for students to learn a range of writing skills through activities such as reporting the results of an experiment or study. This incorporates reading, vocabulary development, speaking and listening.

Kelly used the word 'camouflage' in her report to the class. When she was asked to explain the meaning of this word she said, 'to blend in'. Kelly's comment illustrates the overlap that inevitably occurs with other KLAs. (A fascinating book on camouflage is Animals in Disguise: A journey into nature's deceptions [Zborowski 1993]).

Students find it empowering to use the correct terminology. For example, when Neil described a paper model of his group's technological product he confidently used the word 'prototype' when talking to his peers. When new words are introduced in a meaningful context language becomes more relevant to students.

How do you think the plant study described above could be linked with the English literacy area? Chapter 2 of this book provides many suggestions. Also look for samples of integrated units of work that combine several KLAs through strands and learning outcomes in your state, territory or country curriculum documents. For example, Victoria has a range of resources available online through the website at <http://www.sofweb.vic.edu.au> and through CD-ROMs, such as curriculum@work.

In conjunction with their plant study students were encouraged to make careful observations of evidence of any small animals living on the leaves or bark of their tree. Once again, students could take digital photographs.

Authentic technological activity

The observation and recording task described in the previous section led to the technological activity of designing, making and appraising or evaluating a small animal catcher and enclosure in order to capture and house the animals (such as a slater, which is also known as a wood louse) for closer study. As mentioned previously, in this unit there was a symbiotic interaction between science and technology.

Wendy’s view of technology was influenced by her state department of education’s publication The Technology Studies framework P–10 (Maruff & Clarkson 1988).
We define technology education as 'a process, a way of thinking and doing which satisfies needs in society and the environment' (Jane & Jobling 1995, p. 193). As students engage in a technological process they draw on technological knowledge and, frequently, scientific knowledge, in order to generate their products.

Students were required to work in small groups. Wendy framed the technological activity using the following open-ended design brief.

**Design brief**

- Design and make:
  1. A device for safely catching a small animal, such as a slater.
  2. A suitable container to house the animal until you finish your study (the animal will then be returned to its original habitat).

Some students recognised that the technological task set by the teacher was authentic in that it had a real purpose. Kelly appreciated this authenticity: 'The part I liked best was making the bug house and actually using it.'

*The Technology: Curriculum and Standards Framework II* (Board of Studies, Victoria 2000) describes a technological process in terms of investigating (I), designing (D), producing (P) and evaluating (E). (The term ‘investigating’ is used in a broader way than in chapter 2, where investigating means almost invariably ‘using a fair test’. Often in the I-D-P/M-A/E process the I means ‘researching’, as described in chapter 2). This process can form the basis for a learning contract for a small group when completing a task, such as that described above. You may find, as Wendy did, that your state, territory or country’s curriculum documents and support materials may contain useful information, particularly in reference to the middle years of schooling.

## Designing technological products

'To focus the students’ attention on the aspects of a useful design Wendy asked the class what they needed to think about before deciding on their design. The resultant class brainstorm revealed that the students thought it important to consider safety aspects and the animals’ welfare. At this point a discussion concerning ethics ensued. Students were encouraged to empathise with the animals they were to study and to realise the importance of treating them in an ethical way. It was this discussion that prompted several student groups to place vegetation from the animals’ natural environments in the designed enclosure. When baby slaters emerged in one enclosure the students firmly believed that reproduction occurred as a result of the high quality artificial environment that they had created.

Also during the initial brainstorm students suggested that the design drawings should be to scale and be clearly labelled to show measurements. The type and cost of materials were also important factors to be considered. Wendy provided mainly recycled materials, such as paper, cardboard, plastic soft drink bottles and pantyhose. People in the local community can often provide schools with materials considered by local businesses to be waste. Teachers can request these materials through school newsletters or by directly approaching local businesses, such as timber yards, or retailers who often have large quantities of surplus cardboard or packaging. Some areas have organisations for recycling a whole range of materials. Subject associations for science and technology can usually provide information on such organisations.
Classroom observations showed that the Year 5 students developed technological capability or know-how using basic materials. Wendy recalls:

I can see that the children have developed enormously over the year, and again just using very simple materials, so we haven’t spent a great deal on resources to get them to the stage where they can be given quite a variety of problems to solve and a selection of materials to use and then go about going through that process of designing, then making and then evaluating.

**Evaluating technological products**

Early on in the unit, Wendy emphasised to the children the importance of evaluating their technological products by saying:

When reporting back to the class you need to report on
- how well your catcher worked
- how well your bug house worked
- the animals you found and where you found them, such as on the tree or shrub in the leaf litter or bark around the plant.

Throughout the unit students shared their ideas and experiences by giving oral presentations to the class. Many students talked about how well their catchers and enclosures worked and suggested ways they could improve their products. Liz evaluated her products by saying:

With our catcher it worked well but the bugs could climb up the top and get out, and the slaters could also roll off. So next time I think we had better put something over the top and a flap to close the front.

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**FIGURE 6.2 Liz's bug catcher design, with improvements**

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After carrying out their investigations the students answered specific questions about their technological products; these written reports were compiled into a class book called *Year 5 Bug Catchers and Enclosures*. This book reveals that these students were capable of evaluating their products and redrawing their designs to incorporate modifications as improvements. In evaluating their animal-catching devices and enclosures most students thought their products worked well. Most groups indicated that, during the process they experienced some problems, but they were able to recommend changes to their designs. Although the majority of students thought the available materials were suitable they also suggested different materials that would be better. In Kelly’s written evaluation she recommends using plastic instead of paper for the bug catcher and house combination:

I thought ours was good. The bug catcher, it didn’t work, but I think it would have worked better if we had plastic to make the house out of. If it was airtight, it would have worked better.

**FIGURE 6.3  Design of catcher and house combination**

Students’ written reports can be presented in various ways. As mentioned earlier in this chapter many schools have equipment such as digital cameras and computer microscopes. Both allow photographs (see figures 6.4a and 6.4b) to be inserted into word-processed documents or electronic slide shows. Some digital cameras and microscopes allow short film clips to be inserted into slide shows. Similarly, short audio recordings can be made and added to slide shows.
This unit incorporated most of the technology strands referred to in most curriculum documents. The following aspects of the unit relate to the strands: ‘Materials’, ‘Systems’ and ‘Information’ (AEC, *A Statement on Technology for Australian Schools* 1994).

- **Materials** Students had to consider the materials that were available and their properties. Later they were asked to suggest ways their devices could be improved. Some students suggested alternative materials.

- **Systems** The devices made to catch and house the animals for the study could be considered as a system to allow a scientific study to be carried out.

- **Information** Students were required to present their information orally. They were keen to communicate this in recorded form via video technology. The video titled *Children Linking Science with Technology* (June 1994) shows the unit from the teacher’s and the students’ perspectives. The video makes a case for linking science and technology in the primary curriculum using a project approach.

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**Student ownership and engagement**

**Students asking questions about the animals**

After observing the animals in their enclosures the Year 5 students’ curiosity led them to ask questions about their animals. These questions would fit into each of the categories suggested in chapter 2. Some of the children’s questions could be answered by referring to reference books or the internet. Wendy, as facilitator, guided students to resources, such as the library reference section, and the insect poster on the display board.

Barry, who enjoyed seeking information in this way, said, ‘I liked catching the bugs and making all the things. I liked learning about all the slaters and looking up books to find out information.’
Emma and Liz asked several questions about the slug they found in the leaf litter under their tree. Their questions necessitated that they carefully observe their slug as well as refer to biology books. Scientists classify slugs in the Phylum Mollusca and the Class Gastropoda. The dark areas under the slug’s skin fascinated both girls. During their literature search they identified this area as being the slug’s intestines. They also discovered that their slug was called the Leopard slug. Figure 6.5 shows that Liz was capable of making detailed observations.

![Figure 6.5 Liz's drawing of her slug]

Below is Liz and Emma’s report showing their questions and written answers.

**Our research questions**

1. Do slugs prefer light or dark places?
   - They prefer dark, damp places.
2. What do slugs eat?
   - Slugs eat juicy green leaves.
3. What is the average size of the Great Grey Slug?
   - The average size is 10 inches, or 25 cm.
4. Do slugs come in different colours?
   - Yes! Slugs come in different colours.
5. What is the name of the slug we caught?
   - The name of the slug we caught is the Leopard Slug.
6. What do the intestines of a slug look like?
   - (The students used a reference book to answer this question.)
Emma, who worked with Liz, preferred to draw the small animals they found from different perspectives. Her comprehensive written report clearly identified how the technological products were designed to achieve their purpose. She was aware of the problems encountered by her group, evaluated the effectiveness of the products in terms of their function and suggested modifications to the designs. Emma drew the animals in the enclosure (made from a recycled plastic soft drink bottle) and labelled the living and non-living components of the animals' habitat.

Neil was very interested in how slaters move, as was Morris, whose questions and answers are shown below as 'Slater park facts'. Mary's questions follow on and these reveal that she wanted to find out the position her slater would occupy in the schoolground ecosystem.

**Slater park facts**

1. How many legs do slaters have?
   - 14
2. How does a slater move?
   - A slater moves its back legs first.
3. What's its scientific name?
   - 'Isopod' is the scientific name.
4. How do you tell a male from a female?
   - The female has a yellow stomach.

**Mary's questions**

1. How can you tell a male slater from a female slater?
2. Statistics:
   - How many legs?
   - What is the average length?
   - What is its habitat?
3. What foods does it prefer?
4. How does it move?
5. Babies: colour, size?
6. What are its enemies?
7. Do they live in groups?
8. How does it protect itself?
9. Does it have a big role in the ecosystem?
10. What is its scientific name?

The students' questions indicate what they wanted to know about the animals they found. Many were interested in the animals' body parts and the function of each part. Observations of groups of slaters led students to discover structural differences for themselves. Some students were also curious about the animals' behaviour. They asked, 'Why do slaters curl up into balls?' By the end of the unit, Katy understood that the slaters' behaviour was a means of protection from predators, as she explains:

When we were digging around to find insects on our tree we couldn't really find any at first, because we didn't know that when slaters try to protect themselves they curled up into little balls. We didn't know what they were. We thought they were little things that fall off trees, little seeds, and in the end we found some slaters and a little worm.

Other students also generated explanations for the behaviour of their small animals. Initially, Liz did not know that the animal she found was a slug. By asking questions Wendy encouraged Liz to hypothesise why the animal was so still. Emma suggested
that it was dead. Wendy then extended the girls' thinking by asking, 'What other reasons might there be?' Liz replied, 'It might be scared.' This example shows the importance of the teacher's questioning skills as a scaffolding technique.

**Science concepts related to ecosystems**

The Year 5 students were capable of generating explanations for their observations. For example, Moira accounted for the lack of animals near Cameron's tree in terms of the interdependence between plants and animals. Other students found several kinds of animals living harmoniously in the same habitat. By identifying the food requirements of each animal students were able to locate the place each animal occupied within the ecosystem. They drew food chains, beginning with plants as producers and progressing the chain through to small animals as consumers. They learnt that the earthworm is a special kind of consumer called a 'decomposer'. Snails and slugs eat plants, making them 'herbivores', or first-order consumers. These animals are prey for second-order consumers, such as birds. A food web is more complex and consists of many food chains. The book *Life in a Rotten Log* (Atkinson 1993) is a fascinating story of the ecosystem of a tree after it fell to the forest floor. *Monsters in Your Garden* (Cushing 2003) is an interesting book for children that relates to backyard ecosystems.

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**6.3 Food web in the schoolground ecosystem**

Use the above description to draw two simple food chains. Then, represent part of the schoolground ecosystem as a food web, showing the interrelationships between slugs, slaters, worms, insects, leaf litter, shrubs, trees and birds. One group of students found a spider and a centipede. Slaters are food for spiders and centipedes, so where would these animals fit in your food web?

**Children's conceptions of animals**

Moira talked about insects. Research has shown that following a study of minibeasts some children no longer view insects as animals. For example, Byrne (1993, p. 4) reports that:

> Recently I asked a group of Grade 5 children whether they regarded insects and spiders as animals. Less than a handful in the whole class were generous enough to award these creatures this status.

We recommend referring to the topic as mini-animals rather than minibeasts, thereby reinforcing the idea that insects are animals.

In an earlier study Bell and Barker (1982) investigated how children's views of what constitutes an animal differ from those of scientists. A total of fifteen 5 year olds...
and twenty-three 9–10 year olds responded to the question, ‘Is ——— an animal?’ The majority of both groups of children responded correctly that a dolphin and a horse are animals. Forty per cent of the 5 year olds responded correctly that a person and a spider are animals. However, of the 9–10 year olds, 74 per cent gave a correct response that a person is an animal, but only 17 per cent gave a correct response that a spider is an animal (see also ‘Children’s concept of animal’, chapter 7).

6.4 Children’s views of animals

- Consider the data presented above and briefly describe how children’s views of what an animal is changed with age. Suggest possible reasons why these changes may have occurred. In trying to bring children’s understanding closer to the scientific view of an animal what criteria would you use to characterise an animal?
- Select an age level and describe a sequence of activities that you would use to
  - identify the children’s prior conceptions of an animal
  - challenge their conceptions in order to move them closer to those of scientists.

Scientists continually update classification systems

In the past scientists classified living things into two major groups or kingdoms, these being the kingdom of plants and the kingdom of animals. Following the technological development of high-powered microscopes scientists discovered microscopic organisms that did not seem to fit neatly into the two kingdom categories. Accordingly, to better explain our world, the scientific community devised a new classification consisting of five kingdoms: Kingdom Animalia, Kingdom Plantae, Kingdom Fungi, Kingdom Protocista and Kingdom Monera (see ‘Concepts and understandings for primary teachers’, page 242, for details).

Until recently there were thirty orders of insects in the Class Insecta. In 2001 this number was increased to thirty-one with the discovery of a new order. How was this discovery made? Zompro received some amber (solidified tree sap) that contained insect larvae that were completely different from any he had seen before. The distinct body shape and diet of this particular insect meant that it did not fit into any of the existing orders. Zompro and his team of collaborators (Adis, Moombolah-Goagoses & Marais) gave the mystery insects with armoured covering the common name ‘gladiators’. Because the insects looked like a cross between a walking stick and a mantis the team created the scientific name Mantophasmatodea (Adis et al. 2002).

Another recent example of scientists updating knowledge came about when X-ray video technology revealed how beetles breathe.
Even the most up-to-date biology textbooks, if they address insect respiration, now need revision. With the help of a high-energy particle accelerator, researchers have documented bugs breathing in a manner never before thought possible: like mammals (see <http://www.sciam.com/ontheweb>).

The implication for teachers is that, as classification systems are human constructions, they are being updated as new discoveries are being made.

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### Teaching approaches that value students' ideas and small-group work

Although Wendy's teaching was based on constructivism (for example, she found out the children's prior views about the topic and planned the unit to build on these) in the science and technology unit outlined here she did not apply any specific teaching model such as the familiar generative teaching model (Cosgrove & Osborne 1985; Osborne & Wittrock 1985). This model is based on constructivist principles and challenges learners to modify what they already know by the teacher introducing the scientists' view of a particular concept.

Barker (1991) describes the generative teaching model in terms of four phases: preparation, focus, challenge and application. In this model teacher activity in the preparation phase involves seeking the scientists' and historical views. The focus phase establishes a context and, for the topic 'What is an animal?', the interview-about-instances technique (Osborne & Freyberg 1985) was used to probe the children's ideas. Picture flash cards of a girl, an earthworm, a spider, a butterfly, a bird, a fire, a fish, a tree, a dolphin and a horse formed the basis of discussion as the students worked in groups or the teacher interacted with the whole class. Student responses showed that the majority held a restricted view of animals as large four-legged, furry creatures found in zoos and on farms.

The challenge phase required the students to take specimen bottles outside to look for six animals they could see and six they could catch. After returning with their captured animals the students classified them according to the following schema: the set of animals and the subsets mammals, birds, insects, worms and other groups. The captured animals (generally worms, ants, centipedes, slaters, etc.) challenged the students' prior views. In this phase the scientists' views are introduced along with supporting evidence.

In the application phase students experienced activities to accommodate the new concept, such as a true or false quiz, games and puzzles. These activities assisted the students to make conceptual links with other conceptions they hold.

Another constructivist model used to guide lesson sequences is the interactive teaching approach (Biddulph & Osborne 1984; see also chapter 4). Faire and Cosgrove (1990) provide an example of this model for the topic of mini-animals where two animals were being investigated. First, in a study of snails, students were challenged to find out how snails cope with life, and second, worms were investigated to show the important role they play in agriculture. Faire and Cosgrove suggest the following steps.
**Before views**

Ask students to write down or say what they know about the animal.

**Exploratory activities**

Develop several task cards that encourage the students to focus on the animal parts or behaviour.

**Students’ questions**

Record any questions students ask about the animal.

**Investigations**

Students have ideas about how to investigate their questions. For the worm, these include investigations about eating, habitats, insides and senses. For the snail these include investigations about moving, seeing, reproduction, the sex (female, male or hermaphrodite) of snails, eating, breathing, the insides and the shell.

**After views and reflections**

Students (individually or collectively) indicate what they now know about the animal.

Teachers can link science activities with films that the children may have seen on video or at the cinema. One excellent example is the film *A Bug’s Life*. Following the success of *Toy Story 1 and 2* (1995, 1999) Disney and Pixar decided to create a feature film about small creatures, which they called *A Bug’s Life*. Director John Lasseter believes that all kids love bugs.

> We made a very tiny camera which we called a Bugcam and we dragged it through the grass and it showed up what the world looked like from a bug’s point of view. We had entomologists [people who study insects], including an expert on bug movement. They gave talks to the designers and animators. We even brought live bugs into the studio.

Disney & Pixar 1998, p. 71

In the classroom teachers can make meaningful literacy links by reading books such as *A Bug’s Life* (also available in Spanish). Big books by Robinson and Drew (1993a, b, c) contain information about stick insects (Phasmids), cicadas (Order Homoptera) and ants (Order Hymenoptera), respectively.

### Benefits of working in small groups

To minimise the amount of equipment and consumables required for the technological activities, primary school teachers often organise the students to work in small groups. Group work was an important aspect of the unit described here. The Year 5 students in Wendy’s class decided that, rather than working in friendship groups as they had done in the previous unit, groups would be formed by drawing names out of a hat. On completion of the unit several students commented positively about working in groups with students they did not know very well previously, as the following comments reveal.

**SAM**

If I did this again I’d like to do a heaps different design for the catcher and bughouse. I’d like to work with a different group because I reckon I got to know Katy and Lee a little bit better.

**MORRIS**

I would also like to be in another group because now we know these people. If you were in another group you would get to know other people, too.
In this unit, as well as expanding their knowledge base, students also developed their cooperative skills, as Wendy explains:

There were some excellent examples of children who perhaps in the past have found it very difficult to accept someone else’s idea and have wanted to dominate the situation of learning, and being able to realise that other people can put valuable input into whatever project is being worked on. So the real cooperative skills have been one major benefit.

In order to experience group work for yourself and to develop your ideas about a small animal you can easily keep in the classroom, conduct this activity with a group of friends.

**Group technological activity: designing an enclosure for mealworms**

Mealworms are larvae of small black beetles. You can get them at pet shops and feed them on rolled oats and sliced apple or potato. Mealworms are easily cared for and you can watch the complete insect life cycle of larva, pupa and adult. Suzuki (1989) shows the three stages and suggests keeping them in a rectangular plastic food storage box with holes in the lid. Loosely woven cloth can be cut to size and placed in between layers of food and mealworms. In two weeks adult beetles appear and lay eggs between the layers of cloth. Where do you think the beetles come from? What will come out of the eggs?

Although a plastic food storage box, such as an ice cream container, is suitable for housing mealworms, you could use your creativity by working with a group of friends to design and make your own mealworm enclosure. Start by each drawing a plan of your own ideas for a mealworm house. Then look at each person’s plan and pick out the good parts of the design. Take at least one idea from each person’s plan to place into a final design drawing for the product. The advantage of this process is that each person’s plan is being valued while pressure is on each person to participate in the group.

**Students learning about skeletal systems**

The following activity suggests how you as a teacher might encourage students to work in groups. This activity builds on the knowledge students have gained from studying small animals, such as slaters, which makes it an appropriate follow-up activity to this unit.

Students’ understanding of animals could be further developed if they were given opportunities to compare and contrast the structure and function of the skeletal systems of a range of animals from small ones, such as slaters and butterflies, through to those of pets and finally to humans.

You could organise the students into groups of three or four. This can be through self-selection (“Find two friends to work with for this activity”), drawing group members’ names out of a hat or through teacher selection. One of the goals of this activity is to have each group of students work independently in order to meet the project brief. You could begin the activity with each group constructing a concept map showing what they know about skeletons. An example of such a concept map is given in figure 6.6.
Students could share the knowledge they have about skeletons. Then, each group can pose some questions to help them compare and contrast the skeletal systems of a range of animals including humans. Questions might include the following:

- Why do slaters have their skeletons on the outside of their bodies?
- Why are the bones in a human leg so large?
- What makes a cat’s skeleton so flexible?

A variety of graphic or cognitive organisers other than concept maps can be used to show information. For example, students can use a Venn diagram to compare and contrast information about skeletons (see figure 6.7). For additional ideas and information on graphic organisers refer to Thinking Oriented Curriculum Information which is located at <http://www.sofweb.vic.edu.au>.
To ensure that all students contribute to and feel that they are integral members of the group each group member is allocated or chooses a question to investigate. The children who select to further investigate the human skeleton can use the computer to view the CD *The Ultimate 3D Skeleton*, which is a very informative interactive guide to the human skeleton. This computer program has a selection of short movies and quizzes that test understanding and the names of the bones in the human frame. On completing the task each member can report back to the small group. The group as a whole then decides on how the information is to be presented to the class. It may be in the form of diagrams, models, a collage, or an audiovisual presentation, such as a computer slide show (PowerPoint). Preparing for the presentation will involve further sharing of roles and responsibilities, perhaps taking into consideration the particular skills of the group members. Some may be accomplished writers while others may have well-developed graphics or other artistic skills. Group work is valuable in that it allows each individual's strength to be drawn upon and allows for the sharing of peer views.

### Finding out alternative conceptions about the human body

**ACTIVITY**

In groups, select one member to lie very still on a large piece of butcher's paper. Another member draws around the body using a felt-tipped pen to form a body outline. The group brainstorms the names of any organs they think are inside the body. Group members then have a go at drawing where they think each organ is located. Meanwhile, one member takes on the role of recorder and writes down all the questions asked during the activity. Samples of children's drawings of this activity are provided in Fleer and Hardy (2001).

### Linking a science unit about human body systems with food technology

The activity described above can be extended to form an integrated unit of work on the human body and nutrition. Students work in small groups to investigate and research a body system. They are given the opportunity to design experiments, gather information from texts and websites and, when available, interview parents who work in the health field. Experiments may be along the lines of testing the effect of exercise on the cardiovascular system. Students design the test and record and analyse data. Information and communications technology can be used effectively at all stages of this activity. Digital photographs can be used to clarify written descriptions of the experiment. Data can be gathered using a data logger, entered onto a spreadsheet and graphs generated to assist students to see their results. Short audiovisual clips can also be incorporated; many schools have digital cameras with this function.

A grid of activities relating to this unit can be drawn up combining Bloom's taxonomy and Gardner's (1983) multiple intelligences. Such a grid allows the teacher to cater for the range of learning styles and abilities within the classroom and students can have a direct say in the activities included on the grid.
Videos related to the human body are also readily available and modern medical technology allows views into some body systems such as the digestive system. Some museums have extensive exhibitions relating to all aspects of body systems.

The nutritional aspect of the unit can provide students with a meaningful context for a food technology unit. As part of this unit Wendy gave her students a design brief to produce a healthy school lunch (Jobling 1999).

Students work in small groups of up to four to investigate what constitutes good nutrition using the healthy food pyramid. The investigative phase of the technology unit also incorporates the practicalities of what foods are suitable for inclusion in a healthy school lunch. Student menu planning has to include hygienic food storage, preparation and presentation as well as working within time constraints. Students then produce their group’s lunch at school. Spreading the groups over a week helps overcome issues of access to some facilities. Each group evaluates their lunch using criteria they helped to negotiate. In this way you can see that the sequencing is guided by constructivist principles.

**Appropriate assessment strategies**

In chapter 4 assessment is the focus pedagogical issue. In this section we also consider appropriate assessment strategies that are consistent with constructivist principles. In science, students’ drawings can be an effective assessment tool. The drawings produced in Activity 6.6 above indicate what your group members knew about what is inside their bodies. In the primary classroom this activity could take place near the start of a topic on the human body and later, after discussion, repeated to show what children know by the end of the topic. The comparison of the children’s before and after drawings would indicate the changes that occurred in their thinking and knowledge application.

Typically, there would be more

- body parts drawn
- organs positioned correctly
- organs correctly labelled
- details within the wrist, arms and legs
- structures present, such as the spine, breastbone, eye sockets, ears.

One advantage of using children’s drawings as a comparative assessment tool is that the assessment is easy to organise. All children can do the drawing at the same time. For those who have difficulty writing the labels, the teacher could ask them what the body parts are called and then write the names down for the child (Frost 1997).

Children can also use the KWL strategy for this activity. Children can draw what they know (K), ask questions indicating what they want to know (W), and then communicate what they have learnt from doing the activity (L).

Written forms of assessment are used frequently in primary science and technology. However, this type of assessment suits those students who are competent in this form of communication, but does not give students with strengths in other areas the opportunity to demonstrate their skills. All students should develop their written skills, but over a course or several units students should be encouraged to present information in more than one form.
Originally, Gardner (1983) described seven intelligences in his theory of multiple intelligences (MI): linguistic (verbal or word smart), musical (rhythm or music smart), logical-mathematical (maths smart), visual-spatial (art smart), bodily-kinaesthetic (body smart), interpersonal (people smart) and intrapersonal (me smart). Later he added naturalistic (category smart). Naturalistic intelligence refers to a holistic thinker, classifier and a person who appreciates the environment (Gardner, 1999).

Consistent with MI theory, the following assessment ideas are designed to give students opportunities to communicate their ideas in a variety of ways.

- **Poster presentation**, with students visually representing their ideas.
- **Audiovisual**, in which students present their information using videotapes or DVDs.
- **Making models** with appropriate labelling.
- **Giving a talk**.
- **Computer-aided presentation**. This may incorporate both written and pictorial forms of communication.

Assessment in the case study unit that is the focus of this chapter mainly involved teacher observation. When students reported to their peers they were making judgements about their products. During student reporting sessions teachers can make anecdotal records of:

- students' ability to work cooperatively on a design
- technological skills
- science questions asked
- science understandings
- research skills
- individual learning styles (for example, Barry liked looking up science books, whereas Alison relied on direct observation).

Cumulative assessment checklists – written and oral – which contain records of students' progress in skills such as observation, recording, hypothesising, concept mapping, diagrams, evaluation, self-assessment and reporting, could also be kept.

**Portfolios for assessment**

When planning a curriculum, attention should be given to assessment and its possible effects on indigenous students. Portfolios are recognised as being a culturally responsive form of assessment because they show students’ progress and involve students in self-assessment of their learning. When students compile a portfolio of significant samples of their work academic progress can be monitored. Portfolios promote student choice (because the students can help select the work samples), allow for a degree of autonomy over how performance is shown to others and facilitate two-way communication between teacher and student. Models or photographs of technological products made by the student can also be included in portfolios.

Electronic portfolios are now in use in some schools and cater for a wide range of student cultural backgrounds. Students and teachers record student work samples into folders on the computer system. Work can be scanned, digitally photographed and inserted, short video clips and audio recordings made and saved into folders and work
directly entered, such as in the case of spreadsheets, databases and word-processed documents. At the end of the school year or assessment period the stored information can be burnt onto a compact disk(s).

Other teaching issues
Incorporating Indigenous peoples’ perspectives

Although the animal catcher and enclosure unit incorporates understandings about science that go beyond conceptual knowledge the unit did not explicitly include multicultural or indigenous perspectives. The need to develop culturally responsive curricula has become an increasingly important issue in many countries, including Australia, New Zealand and Canada. In order to design culturally responsive science curricula we should consider indigenous perspectives, such as those of Aboriginal and Maori and Inuit peoples. Indigenous peoples have an intimate knowledge of the environment and base their whole education on their understanding of their local environment. In this section we look at the issue of designing culturally responsive curricula that incorporate indigenous peoples’ perspectives.

In the Australian Aboriginal tradition learning was based on observation and repetition; it was also guided by stories. Knowledge belongs to appropriate individuals in the community and is shared when the youth reach the age of understanding. Children learn from older children and are not encouraged to ask questions. To this day certain knowledge is not shared, for example, women’s business is not sought by men and vice versa.

Teachers who are non-Aboriginal must become aware of the cultural protocols and respect them. If appropriate it may be helpful to consider the way indigenous peoples communicate information about the habits of animals from generation to generation, and the way dances illustrate characteristics of the animals so well, particularly the way they move. Elders could be invited to school to talk about the traditions relating to totem animals. Oodgeroo Noonuccal (1988) talks about protecting the land and her totem, Kabul, the carpet snake or Rainbow Serpent, who is seen as the giver and taker of life. Some Aboriginal groups are not permitted to eat their totem animal, or not at certain times of the year.

Published Aboriginal stories can be useful starting points when designing a culturally responsive curriculum. One easily accessible book that is part of the Australia Post Bookabout series is Dunbi the Owl (Lofts 1983). This story explains why Aborigines are forbidden to harm owls.

In attempting to break down cultural barriers and plan an inclusive curriculum teachers can incorporate into their integrated studies examples of bush tucker and medicines, as well as early technological implements designed by indigenous people. Aborigines who live off the land know the multiple properties of many plants and their uses. The fruit of a particular plant may be eaten, the roots made into dye and the bark or sap used as medicines (Isaacs 1994). Fortunately, Aboriginal expertise in medicinal botany is now being recognised and valued. For a specific illness any one of twenty plants could be used, depending on the locality. In contrast to Western practice most
bush medicines are not taken orally but used as inhalants, antiseptics, rubs or liniments. Aboriginal elders could be invited to the school to share their knowledge of plants and show the students some of the tools they use to gather food (see spear example in Fleer & Jane 2004). Traditionally, indigenous women took their children with them and went out in the bush to gather plants such as berries, fruit, flower cones, roots and tubers; the type of food collected depended on the time of year and the locality. Gathering was a social activity.

**Animals as food**

Traditionally, in the Australian Aboriginal culture, meat preparation and distribution were guided by important rules. Animal foods, such as lizards, snakes and tortoises, were roasted in open fires or pits or steamed in stone ovens. Insects were an important source of protein in the Aboriginal diet – they were usually eaten raw. Grasshoppers, termites and swarming insects, such as the Bogong moth (*Agrotis infusa*) found in the Bogong high plains in New South Wales and Victoria, were eaten. Birds and reptiles (and their eggs) were also a large component of Aboriginal diet.

The most important insect food of the desert is the witchetty grub that is eaten raw or lightly cooked in ashes. In central Australia Aboriginal women collect these grubs in the roots of witchetty bushes (*Acacia kempeana*) and some adult grubs grow to ten centimetres long and two centimetres wide. The digging stick is an implement that Aboriginal women use to collect many kinds of food, including insects and grubs.

Honey ants are another important food source. In the desert near Papunya in the MacDonnell Ranges in South Australia it is strenuous work for Aboriginal women to dig down more than a metre to locate honey ants. These women know that when ants become bloated with nectar they live in underground galleries where they are safe from drought. The bloated ants regurgitate nectar to feed other ants. The behaviour and characteristics of the honey ants could be contrasted with the ants urban students would find in their schoolground and home gardens. The different habitats could also be compared.

In Victoria the traditional Kooris’ (name of Aboriginal people living there) diet includes honey from the hive of the stingless native bee. Once the hive is found a stick is placed in a hole cut in the bottom of the hive, allowing the honey to run down the stick and be collected. Edible galls on acacias are another source of food that results from insect activity. On hunting trips Aborigines rely on these galls to supply them with juicy grubs and refreshing liquid. Crusty patches on gum leaves (called ‘sugar bread’) are another food source found by Aboriginal peoples when they are on bush food-gathering trips. In a similar way, as part of an environmental trail, students in local primary schools could examine indigenous trees in their schoolground for the presence of galls and sugar bread.

Learning outcomes are more likely to be achieved when the teacher takes into account the students’ existing knowledge, skills, values, interests and cultural background. These factors should be considered when planning scientific and technological activities and providing reference materials. Aboriginal students and non-English-speaking background (NESB) students may find technological terms and concepts unfamiliar. By selecting activities and materials from other cultures the science and technology curricula are made more inclusive. Group work, diagrams and annotated drawings, as well as instructions, all help students who have limited English vocabulary.
to develop technological language. Other useful strategies include explaining key terms visually and in context, modelling written and oral tasks and making lists of equipment, concepts and processes.

**Focus pedagogical issue: the community as a resource**

Studies of animals and plants can occur by making use of the schoolground, as Wendy’s unit shows. The school’s gardens contain examples of several plant habitats such as a fern gully and a mallee type section. However, there are many resources available that lie beyond the immediate school environment, for example, some supermarkets feature drought resistant gardens. The local community can be a rich source of both material resources and expertise when planning and implementing units in science and technology. Units based on familiar and local environments have many advantages because there is a platform of common experiences on which to build further learning experiences, for example, the living things students find in their own backyards and in local creeks. Also there is immediate access, and the broader community can be drawn into the learning environment to provide greater enrichment and relevance. In the previous section we considered examples of this enrichment found readily in indigenous communities, where a wealth of knowledge resides with the elders.

School visits to a local park, lake and environmental reserve can provide valuable informal learning experiences. Below, we consider how you might make the best use of a school visit to a wetlands area (also see the focus pedagogical issue in chapter 12).

**School visit to a wetlands area**

Wetlands are places where water levels vary, depending on seasonal rains. Marshes, lagoons and swamps are important areas for many species of waterbirds such as ducks, swans, spoonbills, cormorants and ibis. Small animals form part of the diet of many waterbirds. These low-lying areas can be an additional resource associated with ‘Living things’. A follow-up unit to the case study described earlier in this chapter could focus on a wetlands area.

A successful unit could revolve around an excursion to a wetlands similar to Coolart. Such an excursion can enhance students’ understanding of different habitats, as well as bird characteristics and behaviour. Coolart is located at Somers on the Mornington Peninsula, 80 kilometres southeast of Melbourne (see <http://www.netspace.net.au/~vaee/condirc.htm> and <http://www.parkweb.vic.gov.au/education/pdf/Coolart.pdf>).

One of the main features at the wetland reserve is the ibis colony. From July to October there can be up to 500 pairs of white ibis in the lagoon. The ibis nest in paperbark trees and on artificial nesting structures or pontoons positioned in the lagoon. Each ibis pair produces, on average, three lots of eggs each year. Both parent birds care for the chicks (generally two hatch at any one time) at the nesting site. The adult ibis feed on the nearby paddocks that become moist after rain. The birds use their long pointed beaks to fossick for beetle grubs, insects and water worms, which they regurgitate when feeding their chicks.

On a recent school visit students believed they had observed the entire lifecycle of the ibis: eggs hatching to chicks, young and old chicks on the nest, adult birds feeding their chicks, a dead adult beside a nest and pairs mating while caring for their first brood of chicks.
Chestnut teal are birds that frequent the lagoon. The male chestnut teal is easily recognised by his bright green and tan feathers and is often seen with a female, whose feathers are mainly brown. To assist the chestnut teal to breed, the rangers have placed artificial nesting boxes in the lagoon.

When preparing to take students to an environmental reserve such as a wetlands area, Griffin's (1996) Learners' Inquiry Approach to planning school visits to museums is recommended. Prior to the visit it is important to include appropriate previsit activities designed to encourage students to generate questions to explore during the visit. To make best use of their time while on the school visit, students seek answers to their questions. Back at school, students should be given opportunities to engage in postvisit activities aimed at following up their informal learning experiences.

A similar strategy is working well for school visits to Coolart. As part of the previsit activities students view the video *Coolart: A wetlands experience* (Gane & Tytler 1995), which provides an overview of the main features of this particular environmental reserve. This video is available on loan at the time of booking the school visit. At various times in the video program questions relating to particular areas of interest are raised. Teachers then encourage students to ask questions about Coolart that they would like to find answers to. One school required each student in the class to think of one question to answer during the visit. All the students' questions were compiled, resulting in 23 separate questions. In this way every student's question was valued.

Visitors often see koalas in the eucalypts along one of the walks. One question asked in the video program is, What types of eucalypt do koalas prefer to eat? This question raises a very important issue about conservation and management of wildlife at environmental reserves. The koalas' preference for the leaves of manna gums has led to many of these trees being stripped of their leaves.

Two intervention measures have been introduced at the reserve. First, several koalas have been captured and relocated to Kinglake National Park, and second, zinc metal protectors have been placed around the trunks of the young manna gums and nearby acacias. Observation of these protectors and of several nesting boxes in trees along the woodland walks could lead to fruitful class discussion concerning the care of animals and wildlife management. Observation of extensive areas in which weeds have been removed and indigenous flora replanted leads to revegetation as another issue that could be raised at school. Useful resources for the wetlands are Drew's (1988, 1990) big books. Relevant books that may interest children are *Weird and Wacky Plants* (Cushing 2002) and *Monsters in Your Garden* (Cushing 2003).

Following a visit to a wetlands area you could challenge your students with the technological task of designing, making and evaluating a nesting box for use by birds found in the schoolground. When drawing their designs students need to consider predators such as cats, as well as the birds' feeding habits and sheltering needs. The technological knowledge students develop includes construction basics, such as joining techniques, as well as mounting and siting of the nesting boxes (Boswell 1993; Cheetham 2000). Health and safety aspects must be insisted upon. You could issue tool licences to students when they demonstrate their capability to use specific tools correctly.

People in the community can be the source of further ideas for postvisit activities. One example is described in the activity below.
Temporary care of animals

A tawny frogmouth had nested in a tree in the schoolground. One weekend students discovered that the baby tawny frogmouth had fallen out of its nest. One student in Wendy's class and her family contacted Healesville Sanctuary (appropriate expert) to find out what should be done. Your task in this activity is to:

- find out from experts the feeding and housing needs of a bird found in your area (make sure you have a list of questions written out beforehand)
- design and produce an information poster or pamphlet informing others of the food and shelter requirements of your chosen bird.

A related activity suitable for primary school students would be for them to observe and record native birds and other animals in their local area. They could choose one animal and develop a disaster plan for its temporary care in case of mishap.

A good example (also from Wendy's school) is when a Prep student found a young ringtail possum. It had apparently fallen from a tree during windy weather. A group of students became actively involved in deciding on the temporary needs of the possum until it could be delivered to a wildlife carer, coincidentally, a teacher at a neighbouring school. (The possum pictured was successfully cared for and released.)

Summary

In this chapter the focus has been on a unit of work in which a project approach was followed, with students working in small groups on their technological products and scientific investigations. Technology was not viewed as applied science. A symbiotic relationship existed between science and technology. An excerpt from the teacher's notes is shown in appendix 6.1, which relates to the technological learning outcomes. You might like to construct a similar table based on the chapter and relating to the science emphasis within the unit.

The success of this unit was due to the following constructivist teaching strategies and pedagogical principles being employed:

- the unit commenced from where the students were at, building and extending on what the students already knew
- the unit enabled students to use a familiar environment, the schoolground
- the students' level of physical skills were taken into account; students were not expected to work beyond their capabilities
• the task was appropriate for the students' conceptual knowledge
• the unit allowed for the students' different learning styles; it was student-centred, not teacher-directed. Students posed questions and had ownership of the work, which allowed them to work in the way they felt most comfortable
• the unit incorporated group work, building on the strengths of individuals
• the unit was gender inclusive; discussions enabled girls to try out ideas in a safe, supportive environment with their friends
• the students were given opportunities to reflect on what they had learnt
• the assessment strategies were appropriate.

Concepts and understandings for primary teachers

Scientists now classify all living things into five kingdoms. In Kingdom Animalia are the animals – organisms that eat other organisms – including the meiofauna (very small animals that can only be seen through a microscope). In Kingdom Plantae are the plants – organisms that make their own food using sunlight – such as trees, ferns, mosses and grasses, but excluding seaweeds. Seaweeds are in the Phylum Protoctista along with the diatoms and dinoflagellates and other microscopic organisms that are plant-like because they can produce their own food, though some are animal-like because they eat other organisms (Breidahl 2001). Kingdom Fungi includes toadstools, mushrooms and other fungi that obtain energy by breaking down other organisms. Previously, these decomposers were thought of as plants. In Kingdom Monera are the microbes or bacteria. Some of these microscopic organisms can make their own food while others break down organic matter.

Slaters are classified in the Phylum Arthropoda, Class Crustacea. Crustaceans have a crust (hard case) enclosing their body and usually live in seawater. The slater or wood louse (Isopoda, meaning equal foot) is a crustacean that lives on land. In the Phylum Arthropoda Classes include Crustaceans (ten legs: crabs, crayfish, shrimp; seven pairs of legs: slaters), Arachnids (eight legs: spiders, mites, scorpions) and Insects (six legs). There are more than 1 million known species of Arthropods and, although these invertebrates vary considerably in appearance and size, they all have jointed bodies protected by a tough, waterproof body case (exoskeleton). This exoskeleton moults (is shed) several times during the arthropod's life so that it can grow to its adult size. The animal can move because the exoskeleton consists of plates that are separated by flexible joints.

Snails and slugs eat plants, making them herbivores or first-order consumers. Earthworms, snails and slugs are all hermaphrodites, which means that although they reproduce sexually, each organism has both female and male gonads.

Earthworms (Oligochaeta) are decomposers and feed on rotting organic matter, breaking it down and thereby assisting the recycling of nutrients. Earthworms burrow into the soil, loosening it and in this way create air spaces within the soil. They also excrete worm casts (dung). Earthworms breed rapidly and are easily kept in the classroom in a commercially produced wormery that is available from plant nurseries and hardware warehouses. You need to purchase special compost worms, such as red wrigglers or tiger. (The bushworm is much larger than the introduced species and feeds on native plant waste such as leaves.) Canadian environmentalist David Suzuki describes earthworms as 'amazing gardeners' and gives details about how to make a wormery in Eco-fun (Suzuki & Vanderlinden 2001; see also Helen Cushing's 2002 No-garden gardening).
When you teach units on the human body the following references related to background conceptual information for primary teachers should be useful to you. Stephenson and Warwick (2001) focus on digestion and healthy eating, teeth and bones as well as the benefits of exercise on the blood circulatory system and respiration. Terry (2000) refers to ideas about the human body by finding out what the children in her Year 2 class knew about these questions.

- What does my skeleton do?
- How does my heart work?
- What foods help to keep us strong and healthy?
- What is my skin for?
- Why are our ears such a funny shape?

Appended

Appendix

Appendix 6.1 The teacher’s schematic plan of the small animal catcher and house unit: upper primary technology component

Activities, classroom management ideas and anecdotal comments about what happened are illustrated in the following plan.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Classroom management</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students were encouraged to design their small animal catchers and houses, keeping in mind that recycled materials were to be used.</td>
<td>Students were introduced to the unit as a whole class group. Students were assigned to random groups. The rationale for this was explained in future working situations where generally one does not get to choose colleagues. Individual activity. Students had the opportunity to display their individual ideas and to justify to others the reasons for elements of the design. Small group activity. The members of the group drew the preferred design.</td>
<td>Throughout the unit students gave oral presentations to the class. These presentations gave students the opportunity to explain and to give reasons for the decisions that were made.</td>
</tr>
</tbody>
</table>

The design brief was introduced to students with an explanation for the reasons for such a brief.

**Design brief**

Design and make:

1. A device for safely capturing a small animal such as a slider.
2. A suitable container to house the animals during the study.

Where possible, recycled materials are to be used. Students drew plans individually and then came to a consensus for the final designs, using elements from individual designs. Students incorporated mathematical skills, such as measurement and the use of scales, into their drawings.

Students were encouraged from early on in the unit to evaluate or appraise their work. Initially some students found it difficult to work cooperatively. However, as the unit progressed, their skills in this area developed and most students could appreciate the value of working cooperatively. Ethics formed an important part of the unit and students knew from the outset that all animals were to be returned to their original habitat.
### Activity

Students organised themselves within each group to collect the materials and equipment needed to implement their design. They then assigned tasks to group members to ensure the completion of the two products.

Students presented their products to the class and explained how effectively they performed the function for which they were designed. This was done orally as well as in written form.

Students focused primarily on the functional aspects rather than the aesthetic. The properties of the materials had to be considered when the products were being designed.

Students set out to create an artificial habitat for their small animals.

Students presented their research questions and answers to the science section of this unit in book form as well as making oral presentations.

### Classroom management

Small group activity. Students organise the collection of tools, equipment and materials. They decide who will complete each task.

Small group and whole class. Each group presented to the class.

The materials made available were: cardboard off-cuts, plastic soft drink bottles, pantyhose and masking tape.

### Comments

If students have not had many experiences working cooperatively, it may be necessary to assign each student within the group a specific task. It is important to then rotate these tasks frequently so that each student has the opportunity to develop skills working with tools and equipment, and interpreting design drawings.

**Safety tip**

Students need to be given instruction in the use of tools and equipment such as scissors and Stanley knives. One way to do this is to have a licensing system where students demonstrate their ability to use items in the correct, safe manner. Licences can be issued for each tool.

One group believed that their enclosure was very successful because the skaters reproduced.
References


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CD ROM curriculum@work.


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