Minibeasts: linking science and design technology
by Wendy Jobling and Beverley Jane

Introduction

This chapter is a narrative, based on a case study of a class of Year 5 students who studied minibeasts (small animals - invertebrates) they found in their school environment. In this particular curriculum unit, science and design technology are linked in a symbiotic way; that is, they are dependent on each other – other interpretations of science and technology connections are presented in Chapter 1 (see the section 'Technology-science connections' on p. 38). Before the students could conduct their scientific explorations they had to design and make two technological products – a minibeast catcher and enclosure – for the specific purpose of collecting and housing the animals to be studied. Activities in this unit were student-centred, consistent with an inquiry-based teaching and learning approach espoused by the national Primary Connections resource (AAS 2005), and based on constructivist learning principles as described in Chapter 1.

Embedded in this narrative 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
- engagement through focusing on student-generated questions
- involving students in learning experiences that require the collection and analysis of data to support or refute a hypothesis, illustrating the nature of science
- relating content to science as a human endeavour
- linking several learning areas
- making use of limited resources
- selecting assessment strategies.

The students shaped the story because they had ownership of their work.

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. (Wendy, teacher)

Participation in the unit encouraged the students to value their natural environment, take responsibility for aspects of their learning, work cooperatively and to communicate orally as well as in written form. The time frame for the unit was eight weeks, with sessions of one-and-a-half hours per week.

Following on from this unit, the school concerned developed a greater focus on environmental issues, including sustainability both within the school and the broader community. Actions have included:

- a recycling program for paper, plastics and food waste (food waste is recycled through composting, a worm farm and free-range hens)
- an organic vegetable garden that uses some of the recycled material above
- a greenhouse where indigenous plants are grown for use in local parks
- water conservation and harvesting via rainwater collection tanks
- student participation in programs such as the Model Solar Vehicle Challenge.

These actions have been incorporated into the curriculum at all levels. Many urban and rural schools also have programs where student learning in science is linked to the community.

Taking account of prior knowledge

As highlighted in other chapters, the ideas students bring to the classroom affect how and what they learn. Here, students’ and scientists’ ideas are either integrated into the narrative of the learning unit or referred to in related sections following the narrative. When planning the unit, Wendy took the students’ prior knowledge into account by finding out what the students had done 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.

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 inquiry 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. (Wendy, teacher)
This introductory activity that Wendy described was important because it encouraged students to link new knowledge with their existing knowledge (Harlen 2009; Harlen and Qualter 2009). These students' prior knowledge was about snails. In previous years they had found out the snail's preferred habitat, food and other survival needs. The students had also done activities that involved looking at drawings of snails that showed no two snail shells were the same.

Other prior knowledge would have been gained during the children's informal learning experiences at home with their families (Heliden and Heliden Ommstad 2006). Research by Jane and Robbins (2004, 2006) has shown the importance of intergenerational learning involving grandparents. Their study of everyday interactions between grandparents and their grandchildren has documented a range of science and technology activities that foster young children's understandings of these subjects (Robbins and Jane 2005, 2006). Teachers who hold a constructivist view of learning value these everyday concepts and plan lessons to link with and build on these understandings.

**Students observing and recording**

In order to develop their observation skills, Wendy required the students to re-examine their trees and shrubs and search for animals living on or around these plants. The activity was introduced 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? (Wendy, teacher)

The latter point encourages students to explore ways of representing and communicating their science understandings. The value of multiple student representations and multimodal representations has been highlighted (Carolan, Prain and Waldrip 2008; Tytler et al. 2009) (see the Chapter 1 section 'Representational and related strategies' on p. 29).

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 (see Figure 6.1). 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.

Most schools have access to equipment such as digital cameras and microscopes (e.g., Dino-lite). Students can take digital photographs to record features like those noted by Lisa.
These photographs can then be inserted into students’ written work. The computer digital microscope can be used in the same way. A feature of both devices is the capacity to make short video recordings that can highlight features such as the ways in which some animals move; for example, the movements of some young giant stick insects are similar to leaves moving in the wind.

**Activity 6.1 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 blending of science and literacy (see the ‘Science and literacy’ section of Chapter 1 on p. 38) can be developed more effectively through teaching skills in relevant contexts. Science and design technology can provide the opportunity for students to learn a range of generic
(e.g., writing) and science-specific (e.g., report genres) skills through activities such as reporting the results of an experiment or study. This incorporates reading, vocabulary development, speaking and listening. The Primary Connections resource has been developed with such a focus, and includes specific techniques such as how to use a science journal, vocabulary development through the use of a word wall, and ways of sharing information using a class science journal (AAS 2005). Science Essentials (Brenner 2005) is another resource incorporating literacy.

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 learning areas.

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.

All aspects of language are important in the learning of science and technology. No matter what subject area or topic, all teachers at all levels need to see themselves as teachers of language. Wellington and Osborne (2001) discuss the importance of language and offer suggestions on how to address this issue. They refer to the research that, over many years, has highlighted the language of science as being one of the main difficulties in the learning of science. As demonstrated above, this chapter gives examples of children’s language and its development in the science and technology sociocultural context. A further example is the students’ research questions and how they sought to answer these; their developing awareness of the need to base conclusions on evidence is apparent.

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. Students could take digital photographs, including digital microscope video clips, and incorporate these into a PowerPoint presentation or poster to share with the class. Students sought and gained additional information through reading texts. Some useful teaching and learning strategies related to the reading and writing of non-fiction are given by Wray and Lewis (1997).

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**Activity 6.2 Linking with English literacy**

How do you think the plant study described above could be linked with the English literacy area? Relate your ideas to learning outcomes as described in your English syllabus, considering the different modes of communication: writing reports, procedural texts detailing the construction of each product, speaking and so on. Chapters 1 and 2 of this book provide many suggestions.

**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 design technology.

Wendy’s view of technology was influenced by one of her State Department of Education’s curriculum publications and her training as a facilitator of in-service professional development courses in technology education. We define technology education as ‘a process, a way of thinking and doing which satisfies needs in society and the environment’ (Jane and Jobling 1995, p. 193; cf with Chapter 1). 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.

The part I liked best was making the bug house and actually using it.

*(Kelly, student)*

**Activity 6.3 Authentic (design technology) tasks**

Consider how you would define an 'authentic' task in 'design technology' and in 'scientific inquiry' – for similarities and differences in the ways in which the latter has been interpreted, see Hume (2009). What do you consider to be the key features of each? You may want to look at your education system’s information about design technology or speak to someone who works in an industry requiring the application of design and technology skills and knowledge. Subject associations such as the Design and Technology Teachers Association (DATTA; http://www.datta-australia.asn.au/index.html) are also invaluable sources of information; an Internet search will provide you with contact details for your local association.

**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.

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. (Wendy, teacher)

Evaluating technological products

Early on in the unit, Wendy emphasised to the students the importance of evaluating their technological products.

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. (Wendy, teacher)

Throughout the unit, students shared their ideas and experiences by giving oral presentations to the class. Many students evaluated their products by talking about how well their catchers and enclosures worked and suggested improvements (see Figure 6.2).

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. (Liz, student)

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 (see Figure 6.3).
FIGURE 6.2 Liz’s bug catcher design, with improvements

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 alright, it would have worked better. (Kelly, student)

FIGURE 6.3 Design of catcher and house combination
ICT allows students’ photographs (see figures 6.4a and 6.4b) to be inserted into word-processed documents or electronic slide shows. Short audio recordings can be made and added to slide shows.

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* (Jane 1994; see http://www.deakin.edu.au/arts-ed/education/sci-enviro-ed/video/video_files/video3.php) 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.

**Student ownership and engagement**

**Students asking questions about the minibeasts they found**

After observing the animals in their enclosures or minilabs, 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 students’ 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 enjoyed seeking information in this way:

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. (Barry, student)
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.

![Image of a slug with notes: These grooves can’t be seen very well. The slug has 4 feelers. These are very easily seen markings.]

**FIGURE 6.5 Liz’s drawing of her slug**

Below is Liz and Emma’s report showing their questions and written answers. They used reference books to answer some of these questions.

Our research questions
1. Do slugs prefer light or dark places? They prefer dark, damp places.
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? (Liz and Emma, students)

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 slider 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?
   ‘Isopo’ is the scientific name.
4 How do you tell a male from a female?
   The female has a yellow stomach. (Morris, student)

**Mary’s questions**

1 How can you tell a male slider from a female slider?
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? (Mary, student)

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.
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. (Katy, student)

Other students also generated questions and explanations for the behaviour of their small animals. Initially, Liz did not know that the animal she found was a slug.

WENDY: Why do you think the animal is so still?

EMMA: I think it is dead.

WENDY: What other reasons might there be?

LIZ: It might be scared.

This example shows the importance of the teacher’s questioning skills as a scaffolding technique that extended the girls’ thinking. The response also shows the tendency for young students to interpret animal behaviour in human psychological terms – see Deakin University’s online science and environmental education resources for a discussion of students’ alternative conceptions (http://www.deakin.edu.au/arts-ed/education/sci-enviro-ed/early-years/animals.php). Kallery and Psillos (2004) also discuss anthropomorphism and animism in early years’ science, including teachers’ conscious and unconscious use. They found that the majority of the teachers in their small-scale study who chose to use anthropomorphism and animism did so because of their lack of knowledge about the science topic or issue being taught. This extended to their pedagogical knowledge, where the teachers reported that they did not have appropriate ways to teach science concepts or explain phenomena. Unconscious use was attributed to three factors:

- It had been one way they had acquired their own knowledge.
- It was the way they had learned to present science to young children.
- They were influenced by the use of metaphors in everyday language; a concern about the use of such metaphors is their potential for misleading learners.

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. A more recent publication of the same name (Penny 2004) also describes the process. Monsters in Your Garden (Cushing 2003) is an interesting book for children that relates to backyard ecosystems, while Ask Dr K Fisher about: Minibeasts (Llewellyn 2008) covers information about survival, habitats and food sources.
Activity 6.4 Food web in the schoolground ecosystem

Use the above description to show 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?
• Consider the ways in which such information can be represented, such as your students role-playing a food web using knitting wool to make the connections.
• Discuss the strengths and weaknesses of each representation in terms of what is and is not communicated.
• Refer to other chapters of this book (e.g., 1, 3 and 8) for further ideas about learning with a representational focus.

Children’s conceptions of animals

Moira talked about insects. Research has shown that following a study of minibeasts, some students 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’.

The differences in students’ definitions of animals and those of scientists has been a research focus for many years. Bell and Barker (1982) investigated how children’s views of what constitutes an animal differ from those of scientists. A total of 15 five-year-olds and 23 nine- to 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 five-year-olds responded correctly that a person and a spider are animals. However, of the nine- to 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.

Further to this, there have been studies dealing with students’ ideas about vertebrates and invertebrates. The range of definitions of insects held by students is discussed by Shepardson (2002) in his study of students from kindergarten to Year 5. He found that primary students tended to view the interactions between humans and insects as detrimental to the former. Students such as Moira showed through their studies during this unit that they had gained a broader understanding of the role of insects and other invertebrates within an ecosystem (consistent with recommendations for student explorations of insects in their natural settings). The need for first-hand experiences is also discussed by Braund (1997) in his earlier study of students’ ideas about animals with and without backbones (see also the Chapter 7 section ‘Children’s conception of animals’; p. 249).

Activity 6.5 Children’s views of animals

• Consider the data presented above and briefly describe how students’ views of what an animal is changed with age.
• Suggest possible reasons why these changes may have occurred. In trying to bring students’ 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 students’ prior conceptions of an animal
  - challenge their conceptions in order to move them closer to those of scientists.

Scientists continually update classification systems

Students need to understand that the process of classification is something that everyone engages in and that classification systems are created for a purpose. In the case of the classification system used by scientists, the purpose is to communicate insights about living things, and it is like a common language. 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 the ‘Concepts and understandings for primary teachers’ section at the end of this chapter, on p. 242, for details).

It is important to note that the classification of living things is not static but rather reflects the NOS as an ongoing process and is at times a cause for debate. An example of this is the Kingdom Protoctista, where it is common for the term ‘protista’ to be used. Rothshild (1989) discusses the terms protozoa, protista and protocista, and relates some of the history involved, including issues such as the classification of some organisms as animal or plant and unicellular or multicellular – this is also mentioned briefly by Haselton (see http://www.bio.umass.edu/biology/conn.river/protoc.html).

Until recently there were 30 orders of insects in the Class Insecta. In 2001, this number was increased to 31 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-Gogoses and 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 from manto the mantids and phasmatodea the phasmds leaf or stick insects (Adis et al. 2002). Insects from this order are also known as Heelwalkers.

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’ (Wright 2003).
The implication for teachers is that, as classification systems are human constructions, they are being updated as new discoveries are being made. The human construction of such systems also needs to be considered in relation to culture, including indigenous ways of knowing. A 1998 study (Chen and Ku) involving aboriginal students from Taiwan (grades 2, 4 and 6) found, for example, that over half of the students classified earthworms and spiders as insects, and ‘nearly 10% in each grade classified a turtle, a snake, or a frog as an insect’ (p. 61). The students lived in a mostly natural environment where one of their food sources is wildlife. Thus, students’ experiences and knowledge of animals differed from those experienced by their non-aboriginal peers even though both received ‘a standard Chinese education’ (ibid., p. 56). Grade 2 students and nearly half of the Grade 6 students did not consider humans as animals, although the researchers could not be certain that this was a cultural influence. They noted the use of daily language in mainstream culture (accessible to the students through television and film) where common expressions tend to separate humans from animals.

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 design technology unit outlined here, she did not apply any specific constructivist teaching schemata as described in Chapter 1. Three examples of lesson sequence schema that have been applied to topics similar to the case study in this chapter are described next. They could be used to guide some lesson sequences that you could implement on this theme.

Barker (1991) describes the generative teaching model (Cosgrove and Osborne 1985; Osborne and Wittrock 1985) 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 and 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 and so on) 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.
Although the strengths of this approach are its student-centred focus and the way in which links are made to prior views, there are some weaknesses. The impression is given that students’ conceptions will be developed quickly and without embedding them within a scientific inquiry. Metz (2008) discusses the importance of students ’doing science’ – also see the online Appendix 1.2 (Skamp 2007). Metz describes how even Year 1 students are able to participate in the knowledge-building practices of scientists.

Another constructivist model used to guide lesson sequences is the interactive teaching approach (Biddulph and 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. Firstly, in a study of snails, students were challenged to find out how snails cope with life, and secondly, worms were investigated to show the important role they play in agriculture. Faire and Cosgrove suggest the following steps:

1. **Before views** – Ask students to write down or say what they know about the animal.
2. **Exploratory activities** – Develop several task cards that encourage the students to focus on the animal parts or behaviour.
3. **Students’ questions** – Record any questions students ask about the animal.
4. **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), eating, breathing, the insides and the shell.
5. **After views and reflections** – Students (individually or collectively) indicate what they now know about the animal.

Although Metz showed how students were able to participate in authentic science practices, Kanter (2009) suggests that not all project-based curricula result in an improved understanding of science content. It is important to consider the nature of such projects. Kanter (p. 526) identifies two major types: those focused on an investigation seeking to answer a ‘puzzling question’, and those based on performance, such as designing and implementing ways to improve the flight of a model rocket. Although there are studies showing the benefits of both, he cites examples where the latter resulted in students retaining unscientific understandings, or not learning the skills needed to allow them to design their research so that they could evaluate their data effectively.

The Faire and Cosgrove (1990) approach is in line with the 5E constructivist learning schema as described, for example, in the Primary Connections resource (AAS 2005): the phases are engage, explore, explain, elaborate and evaluate. Look at each of these phases in the Primary Connections unit ‘Schoolyard Safari’ (AAS 2008), which focuses on students in their second and third years of school. How do the activities in this unit compare to those in the study above and in those described in this case study of Year 5 children studying minibeasts?

Teachers can link science activities with films that the children may have seen on DVD or at the cinema. One excellent example is the film A Bug’s Life. Following the success of the first two Toy Story instalments (Walt Disney/Pixar 1995, 1999), Disney and Pixar decided to create a feature film about small creatures. 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.

Walt 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, 1993b, 1993c) contain information about stick insects (phasmids), cicadas (Order Homoptera) and ants (Order Hymenoptera), respectively. Using film, fiction and non-fiction books as models, children can develop their own pages for a class book or short animated film focusing on invertebrates found in their own school environment. Websites such as that of Museum Victoria (http://museumvictoria.com.au/bugs/exhibition/index.aspx) provide information in various forms that are suitable for students.

Benefits of working in small groups

To minimise the amount of equipment and consumables required for 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 buighouse. 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:

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.

(Wendy, teacher)

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. The appendices in each of the Primary Connections units (AAS 2005) describe in detail the benefits of cooperative learning teams as well as how to organise them. One strategy is to assign roles to each student, ensuring that these are rotated in order to provide each student with leadership opportunities. The website also provides this information in electronic form.
Activity 6.6 Cooperative technological activity: designing a mealworm enclosure

Mealworms are the 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 put on each person to participate in the group. Consider how you could use this activity with your primary students.

Students learning about skeletal systems

The following activity suggests how you as a teacher might encourage students to work cooperatively. This activity builds on the knowledge students have gained from studying invertebrates, 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).
FIGURE 6.6 Concept map showing understanding of skeletons

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. 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 using ICT (for example, diagrams, a short recorded presentation incorporating models, a collage or a presentation, such as a PowerPoint or web pages). 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,

FIGURE 6.7 Venn diagram comparing and contrasting information about skeletons
ICT 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.

When you teach units about the human body, the following references relating to background conceptual information for primary teachers are useful. 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 the following 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?

**Activity 6.7 Finding out alternative conceptions about the human body**

The students in this unit studied invertebrates, some of which had an exoskeleton (e.g., slaters). Questions about the function of such structures have been suggested earlier. Building on these previous activities, 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. If adapting this activity for your primary students, you may want to begin with a whole-class brainstorm of organ names, with these placed on a word wall.

**Human body systems and food technology**

The activity described above may be extended to a unit of work on the human body and nutrition. Students can 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 the data. ICT 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.

A grid of activities relating to this unit can be drawn up to allow for a range of children's learning styles and abilities (e.g., 'gifted') within the classroom. Students can have a direct say in the activities included on the grid.

DVDs/videos related to the human body are readily available and modern medical technology allows an intimate viewing of some body systems (such as the digestive system) –
the updated DVD version of The Magic School Bus – Human Body (Degen and Cole 1994/2005) and Human Body (Winston 2010) are two examples. 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 food technology. Although the context is set by the teacher, ownership is then given to the students to initially gain their interest and then to promote ongoing engagement (see the Chapter 1 section ‘“Hot” conceptual considerations: student engagement’ on p. 25). Students can be challenged by 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 technological process 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’ activities out 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, the sequencing is guided by constructivist principles.

**Appropriate assessment strategies**

In this section we 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 6.7 (see p. 235) 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, be 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 KWLH strategy for this activity. Children can draw what they know (K), ask questions indicating what they want to know (W), then communicate what they have learnt from doing the activity (L) and finally describe how they learned it (H).

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. The Primary Connections units (AAS 2005), in each of the 5E phases, provide descriptions of assessment tasks incorporating multiple literacies and multimodal learning; these include student drawings and diagrams.

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
- ICT presentations, which may incorporate both written and pictorial forms of communication.

Assessment in the unit that is the focus of this chapter mainly involved teacher observation with anecdotal notes of student presentations. Students self-assessed their work when they reported to their peers as they made 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).

Black (2008, p. 21) describes design and technology as particularly rich in terms of the ways in which they can be used to develop independence in students in terms of their learning: ‘they can be required to make and take responsibility for their own decisions about their designs and subsequent products’. Effective formative assessment of technological skills is an essential component of an effective learning environment. Black provides a number of strategies, one of which is the use of teacher questioning to focus students’ attention on specific aspects of their task. Such questioning and associated dialogue took place throughout this unit, not only providing students with feedback but also informing teaching.

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. An Internet search can locate many examples of assessment rubrics. Education department websites can also provide examples and guidance about rubrics (see, for example, http://www.education.vic.gov.au/studentlearning/assessment/preptoyear10/tools/rubrics.htm).

Science as a human endeavour

Studying invertebrates within the school’s grounds enabled the students in this study to gain firsthand experiences with socioscientific issues such as biodiversity; they sampled the small animals within their school community. The health of their school environment and the ecosystems within it enabled them to gain a greater understanding of science as a human
endeavour (e.g., see ACARA 2011), including the associated ethical issues. Within this strand it is important to also take into account other perspectives such as those held by Indigenous communities.

**Incorporating Indigenous peoples’ perspectives**

In Chapter 1 (see the section ‘Science and culture: Indigenous and cultural knowledge’ on p. 42), the need for teachers to acknowledge that different world views may be held by their students and themselves is discussed. At the commencement of this unit, links were made to students’ previous experiences and existing understandings, but other cultural or Indigenous perspectives were not identified.

The need to develop culturally responsive curricula has become an increasingly important issue in many countries, including Australia, New Zealand and Canada – in Australia, the *Primary Connections* resource (AAS 2005) has published material on Indigenous perspectives (see http://www.science.org.au/primaryconnections/indigenous). In order to design culturally responsive science curricula, we should consider Indigenous perspectives. Indigenous peoples have an intimate knowledge of the environment and base their whole education on such understanding.

In the Australian context, traditional learning was based on observation and repetition; it was also guided by stories. Knowledge belongs to appropriate individuals (elders) 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.

All teachers 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 Indigenous groups are not permitted to eat their totem animal, or at least not at certain times of the year.

Published stories can be useful starting points when designing culturally responsive curricula. One easily accessible book is *Dunbi the Owl* (Lofts 1983). This story explains why it is forbidden to harm owls.

In attempting to break down cultural barriers and plan inclusive curricula, teachers can incorporate into their integrated studies examples of bush tucker and medicines, as well as early technological implements designed by Indigenous people. People 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, Indigenous expertise in medicinal botany is now being recognised and valued. For some illnesses, any one of 20 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. 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 the spear example in Fleer and Jane (2004). Traditionally, Indigenous women took their children with them into 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 Australian Indigenous cultures, meat preparation and distribution were guided by important rules; for examples provided by members of an Indigenous community, read *Ngurra-kurlu: A Way of Working with Warlpiri People* (Pawu-Kurlpurlurnu, Holmes and Box 2008). 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 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 the diet.

The most important insect food of the desert is the witchetty grub, which is eaten raw or lightly cooked in ashes. In central Australia, women collect these grubs in the roots of witchetty bushes (*Acacia kempeana*); some adult grubs grow to 10 centimetres long and 2 centimetres wide. The digging stick is an implement that 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 the Northern Territory, it is strenuous work for 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 Koori 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, Kooris 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 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. Indigenous 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.
Temporary care of animals
Science as a human endeavour includes ‘responding to social and ethical issues’, and when ‘science research is influenced by societal challenges or social priorities’ (ACARA 2011, p. 4). The students in this unit were involved in a study that was set in their school environment. Ethical issues concerning the treatment of the animals studied featured in both the design and use of the technological products, as well as the nature of the students’ science inquiries. (Further links are also made when addressing health and nutrition issues, as described earlier when looking at human body systems and food technology.) Opportunities for students to engage in authentic experiences of science as a human endeavour can arise through incidents such as those described in Activity 6.8.

Activity 6.8 Learning from experts
Opportunities for children of all backgrounds to develop and apply science knowledge can arise through incidents where young animals are separated from their parents.

A tawny frogmouth had nested in a tree in a Victorian 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 (the appropriate expert) to find out what should be done. Your task, as adults, 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.

**FIGURE 6.8** The possum that was saved and released
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.)

Please note that there are particular regulations in some States and Territories that apply to the use/care of animals in schools and that these should be consulted by teachers to avoid any difficulties. If indigenous animals are found by students, teachers should refer to their appropriate State or Territory wildlife authority.

Summary

In this chapter, the focus has been on a unit of work in which a project approach encouraged students to work in small groups on their technological products and scientific investigations. Technology was not viewed as applied science. Rather, a symbiotic relationship existed between science and technology. Three science content strands are described in some curricula. For example, in ACARA (2011) there are science inquiry skills, science as a human endeavour and science understandings. In ACARA (2011, p. 14), the relationships between technology (and design) and science are outlined. An excerpt from the teachers’ notes is shown in the online Appendix 6.1, which relates to technological learning outcomes. You might like to construct a similar table (based on this chapter) that relates to the science emphasis within the unit identifying where and how student activities link to the three science content strands.

This unit was successful 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 they already knew. It enabled students to use a familiar environment: the schoolyard. Their levels of physical skills were taken into account and they were not expected to work beyond their capabilities. The task was appropriate for the students’ conceptual knowledge and allowed for their different preferred learning styles. It was also student-centred rather than teacher-directed. Students posed questions and had ownership of the work, which allowed them to work in the way they felt most comfortable (cf. science inquiry skills in ACARA (2011)).

The unit incorporated group work, building on the strengths of individuals. It was also gender-inclusive, with discussions enabling girls to try out ideas in a safe, supportive environment with their friends. The ethical approach to the needs of the animals studied by the children (science as a human endeavour) helped to ensure that the unit was culturally sensitive. The students were given opportunities to reflect on what they had learnt and appropriate strategies were used to assess this learning. To conclude this unit required students to consider not only the ethical treatment of the animals studied (as described above) but also their place within ecosystems in their school environment.
Concepts and understandings for primary teachers

Students in this unit studied invertebrates (minibeasts) within ecosystems found in their schoolground. The school in which this unit was taken was and still is concerned with its students developing an understanding of environmental issues such as the importance of biodiversity and sustainability. It has a well-developed recycling system, including composting, worm farms, hens and an organic garden. The following information is provided in the form presented to also convey a sense of the connections between living things. Although there is perhaps not the same clear listing of concepts as in other chapters, it is important to keep in mind those that apply. The challenge of providing learning contexts and activities that will shift deeply held alternative conceptions also needs to be kept in mind (Arnaudin and Mintzes 1985).

Scientists now classify all living things into five kingdoms. (As discussed earlier, it is important to note that this is an ongoing process, as in the example of the Kingdom Protostoma or protista.) 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 in the process of photosynthesis – such as trees, ferns, mosses and grasses, but excluding seaweeds. Seaweeds are in the Phylum Protostoma classification 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 sea water. However, the slider or wood louse (Isopoda, meaning equal foot) is a crustacean that lives on land. In the Phylum Arthropoda, the Classes include Crustaceans (animals with 10 legs: crabs, crayfish, shrimp; and animals with seven pairs of legs: slaters), Arachnids (animals with eight legs: spiders, mites, scorpions) and Insects (six legs). There are more than one 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. Despite the hard outer covering, the animal can move easily because the exoskeleton consists of plates that are separated by flexible joints.

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

Earthworms (Oligochaeta) are decomposers that feed on rotting organic matter, breaking it down, thereby assisting the recycling of nutrients. Earthworms burrow into the soil, loosening it and in this way creating air spaces within the soil. They also excrete worm casts (dung). As earthworms are fast breeders, they 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 and Vanderlinden 2001); see also Helen Cushing's (2002) No-garden Gardening.
CHAPTER 6 Minibeasts: linking science and design technology

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Explore Search me! science education for relevant articles on linking science and design technology. Search me! is an online library of world-class journals, ebooks and newspapers, including The Australian and the New York Times, and is updated daily. Log in to Search me! through http://login.cengage.com using the access code that comes with this book.

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- ICT and science

Search tip: Search me! science education contains information from both local and international sources. To get the greatest number of search results, try using both Australian and American spellings in your searches: e.g., ‘globalisation’ and ‘globalization’, ‘organisation’ and ‘organization’.

Appendices

In this appendix you will find material related to ‘minibeasts’ that you should refer to when reading Chapter 6. This appendix can be found on the student companion website. Log in through http://login.cengage.com using the access code that comes with this book.

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

This plan describes activities, classroom management ideas and anecdotal comments about what happened during the unit’s implementation.

References


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