PART 1

Researching 'What is Technology and Technologies Education'

This book has been designed to be interactive. You are invited to replicate the research presented in the forthcoming chapters in this book. In documenting research evidence, greater understandings will be gained about the nature of technologies education. You are encouraged also to consider the 'Pedagogical reflections' and 'Research activities' posed in the chapters. Try not to read on unless you have at least thought about your views on the questions raised. By so doing, the text that follows will be more meaningful and will position you as someone who is contributing to building, rather than just receiving, knowledge about the curriculum area of technologies. Through this process, you will be able to gain insights into what it means to be a researcher and teacher of technologies education for children from birth to 12 years. Although explicit reference is made to the Australian Curriculum – Technologies, this book seeks to go beyond just this particular interpretation of technologies. As will be shown throughout the book, views on what is technology, and therefore how to teach technologies education, are constantly changing. At the time of writing, the Australian Curriculum was under review (http://www.acara.edu.au/home_page.html) and changes to specific wording were made. Here is what was documented on the Australian Curriculum, Assessment and Reporting Authority (ACARA) website at the time:

> ACARA is seeking to improve the learning of all young Australians through the development of a national curriculum. Work is underway to improve the Australian Curriculum, addressing themes endorsed by the Education Council. These themes

> are: uncrowding the curriculum; rebalancing the curriculum; improving accessibility for students with disability; and parental engagement.
>
> ACARA is undertaking a program of work of developing, consulting and seeking agreement in relation to proposed actions. This includes undertaking targeted consultation with key stakeholders, including state and territory curriculum, and school authorities and practising teachers, around any changes.

This is the nature of curriculum, both in Australia and internationally. What is key, is being a part of this journey and the search for better conceptualisations and approaches to the teaching of technologies. This book seeks to support you in this important journey.

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CHAPTER 1

The contexts of technologies and technological knowledge

Introduction

The terms 'technology' and 'technological literacy' are heard in many different forums (e.g. Dakers, 2014). Newspapers often feature articles relating to technology. Many politicians associate economic success with technological products and capabilities (Freeman, Marginson and Tytler, 2015). Yet what do we really mean when we talk about technology, and what constitutes knowledge in technology education? This book brings together research on technologies education. You are invited to reflect critically upon this research by recording your reactions to the examples of teaching practices, children's comments and work samples, and research that are presented in each chapter.

The aims in writing this chapter are for you to clarify the meaning of technology, to think about the people behind various technologies, and to broaden your perspective of how global issues relate to technology. Armed with this knowledge, you are invited to think about the ways you might challenge children through planning activities that are set in purposeful technological contexts (see Figure 1.1). This is in keeping with the international evidence which says that the most successful countries in science, technology, engineering and mathematics (STEM) are those who have made learning 'more engaging and practical, through problem-based and inquiry-based learning, and [with] emphases on creativity and critical thinking' (Freeman, Marginson and Tytler, 2015, p. 10).

Figure 1.1 Engaging children in technology education – do children think about materials technology?

PEDAGOGICAL REFLECTION 1.1: WHAT IS TECHNOLOGY?

What do you understand by the term 'technology'? What are your images, concepts and feelings about technology in general, and how does technology fit in with your life and society as a whole? Record one key idea.

What follows are some responses from student teachers to this question:

- Technology is everything we use around us – construction, clothing, tools, computers, machines, medicines, etc.
- We couldn't function as efficiently without technology, and probably wouldn't have as much leisure time.
- I have negative feelings with regard to the impact new technologies have had on the environment.
- Technologies have contributed to the emancipation of women.
- It feels challenging and overwhelming when you don't know how to use it.

Were your views similar?

Thinking about what is the nature of technology and technologies education is important for building your own personal approach to teaching this important curriculum area. To broaden your thinking about the nature of technology, this

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chapter begins by exploring the people behind technology, considering societal views of technology, and contemplating the cultural dimensions of technology (see Figure 1.2). The chapter will conclude with an overview of the Australian Curriculum – Technologies (ACARA, 2015).

Figure 1.2 Is this technology?

The people behind the technology

Researchers have been interested in the connections between science, technology, engineering and mathematics for quite some time, linking them together in a range of ways over the years. Connecting these discipline areas is highlighted in the work of technologists. The following narratives about technologists themselves shed light on how inventions come about and how technological products were and can be developed.

Knowing about technologists, their passions and their career milestones is relevant today because technology is constantly changing. We can learn a great deal from reflecting on the past and looking at individuals who made a difference in their particular sphere. Teachers of technologies can highlight for children the people behind the technology and how they came up with cutting-edge technologies (Jane, 2008). Several narratives follow.

Computer technologies

In 1976 Steve Wozniak and Steve Jobs successfully launched Apple Computer I (or Apple I), yet neither of them had a university degree. They began a business in Jobs' garage bringing the computer to market. Wozniak has described himself as a natural risk taker and 'just a good engineer, doing what I was meant to do in life' (Wozniak, cited in Leyden 2008, p. 101). Since leaving the company in 1987, Wozniak has taught for eight years in primary schools, written an autobiography, developed and brought to market the first universal TV remote control, and helped float a technology development company. He says he is only interested in technology for the masses, and believes that anyone can be a technologist. However, he advises would-be entrepreneurs against starting a company with just a good idea, because the ability to build the technology is equally important.

Because of Bill Gates' vision of the personal computer, Microsoft became a leading computer and software company, making him one of the richest men in the world almost overnight. Gates also imagined what was to become the internet revolution, and in 1996 he radically reinvented his company around the internet.

During Gates' time as a student at Lakeside School in Seattle, the Mothers' Club did some fundraising to provide a computer terminal and computer time for students. Gates wrote his first software program, for playing tic-tac-toe, when he was 13 years old. The computer was huge and cumbersome and writing the program was slow because there was no screen with the computer terminal. After typing the moves on a typewriter-style keyboard, Gates and his friends had to wait until the results sluggishly emerged from a printer before they could decide on the next move. Gates recalls:

> A game of tic-tac-toe that would take thirty seconds with a pencil and paper might eat up most of a lunch period. But who cared? There was just something neat about the machine. I realized later that part of the appeal must have been that here was an enormous, expensive, grown-up machine and we, the kids, could control it. We were too young to drive or do any of the other things adults could have fun at, but we could give this big machine orders and it would always obey. (Gates, 1996, pp. 1–2)

Games technologies

Game pioneer Allan Alcorn, the designer of the world's first popular video game (in 1972), was a junior engineer at Atari and his first task was meant merely to test his skills. However, the result was 'Pong', an electronic table-tennis game that led the way for modern video games. In contrast to coin-operated pinball machines, Pong was a social game that required two players, and it was the first game that appealed to young females. Alcorn said:

> I enjoy talking about the early days of video games and the fun we had. Perhaps I can inspire a young person to get involved in science and technology. Video games are part of a worldwide culture and as such we need to understand where it came from and where it is going. I hope that as a medium for entertainment it will add to the public good. (Alcorn, cited in Parker and King, 2008, p. 29)

Figure 1.3 Digital technologies increase access to new ways of thinking, being and working

Although the above examples relate to *information technology*, it is possible to notice that science, technology and engineering are needed, and in the real world these often overlap. We can also see that there are different types of STEM professionals needed in information technology development (see Figure 1.3), and these professionals work together when testing devices and materials to determine which are most suitable for the realisation of their designs.

Biomimetics

The new field of biomimetics, which mimics designs in nature, points to future directions in engineering. Some examples follow.

Biomimetics – Velcro® technology

The narrative of the founder of the product Velcro®, George de Mestral, is a good starting point for a discussion of biomimetics. He trained as an electrical engineer, and was fond of hunting in the lower slopes of the Jura Mountains in Switzerland. De Mestral's grandson said: 'Everyone remarked that he was often lost in his own world. In that "own world" of his he was on the lookout for fasteners' (Forbes, 2006, p. 94). De Mestral was motivated by the frustration of trying to fasten the hooks and eyes on his wife's evening dresses. Not wanting to be late for social functions,

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he thought that there must be a better method of fastening garments. In 1948, after one of his hikes, he was examining the burs that he had plucked from his pants and his dog's coat, and found that their spines were tipped with tiny hooks. This observation sparked his invention of Velcro® (Mueller, 2008).

Fashion designers did not adopt his product until later, when nylon became available after the end of World War II (although it had been invented in 1937). Early applications of Velcro® were used in the first artificial heart surgery. Another early user of the hook-and-loop construction that grips instantly, but with a tug lets go, was NASA, which incorporated Velcro® in the space boots worn by its astronauts in the moon exploration missions. The *Apollo* astronauts also wore gloves with Velcro® tabs so they could latch down loose items when in zero gravity. The original patent was filed in 1951 and the product came to market in 1955.

The progression from the hook-and-loop or hook-and-eye fastener to gecko adhesion shows the size reduction in nanostructures. Designers are currently exploring the unique features of the gecko's toes, each of which has 6.5 million spatula-tipped hairs that adhere to surfaces, enabling the gecko's gravity-defying locomotion across walls and ceilings. The team, consisting of Mark Cutkosky (roboticist), Sangbae Kim (designer), Bob Fuller (expert in animal locomotion) and Kellar Autumn (a world authority on gecko adhesion), developed Stickybot, a 500-gram robot, using a shape deposition manufacturing (SDM) process. Designers hope that one day Stickybot may have search-and-rescue applications. Cutkosky said:

> I'm trying to get robots to go places where they've never gone before. I would like to see Stickybot have a real-world function, whether it's a toy or another application. Sure, it would be great if it eventually has a lifesaving or humanitarian role ... (Cutkosky, cited in Mueller, 2008, p. 86)

Biomimetics – multidisciplinary teams for solving technological problems

The narrative of Andrew Parker (an evolutionary biologist and leading proponent of biomimetics) shows how he is applying designs from nature to solve problems in engineering, materials science and medicine. For example, Parker investigated iridescence in butterflies and beetles, and antireflective coatings in moth eyes, and his research led to brighter screens for cellular phones (Mueller, 2008). 'Biomimetics brings in a whole different set of tools and ideas you wouldn't otherwise have', says materials scientist Michael Rubner of Massachusetts Institute of Technology (MIT), where biomimetics has entered the curriculum (Mueller, 2008, p. 74).

Parker is now seeking to create a water collection device, inspired by the skin of the thorny devil lizard that lives in the arid Australian desert. When ready to make a prototype, he sends his observations and experimental results to Rubner and MIT colleague Robert Cohen (a chemical engineer). These people have worked as a team, linking biological insight with engineering pragmatism to produce several successful biomimetics projects.

Biomimetics – inclusive technologies

A further example of biomimetics can be seen in the work of bio-inspirationist Joanna Aizenberg on the microfabrication of crystal structures that has resulted in technical products. Aizenberg has different skills from those researchers who analyse natural structures. Her expertise in biomineralisation (the science of how mineral lattices are formed) was utilised at Bell Laboratories in New Jersey in the United States. In 2003 she discovered that at the base of the sea sponge Venus flower basket (*Euplectella aspergillum*) there are fine spines or whiskers that are made of optical fibres of superior quality. She is also working with the brittle star lens system, and has shown that it is made from a single crystal of calcium carbonate. She found that each lens is engineered to bring the light to a focus according to the same principle as that first devised by Descartes and Huygens in the seventeenth century (Forbes, 2006). The lens array focuses the light at a point where there is a nerve receptor, 4 to 7 micrometres below the surface of the lens. Aizenberg is aiming to create technical equivalents, to generate a new type of lens system that could help people who suffer from blindness. She is seeking to understand the modulating factors that affect crystal growth patterns and to produce crystal structures similar to those in nature.

These vignettes reveal the people behind the technologies, how they were inspired, what led to their break-through discoveries, and how they worked. Technologists often work in multidisciplinary teams, testing materials and designing useful products to make life easier and improve the general quality of life for everyone. Technologies work in real contexts, and this is something that teachers should consider when thinking about creating learning opportunities for children.

PEDAGOGICAL REFLECTION 1.2: WHAT ARE THE TECHNOLOGICAL CONTEXTS IN OUR SOCIETY?

What other professions do you associate with technology? Make a list of the professions in a table such as that shown in Table 1.1, give a reason for why you have selected the professions, and illustrate your thinking with an example of the technology they work with. Consider what might be all the technological contexts in our society. You will come back to your response in Research activity 1.2.

Table 1.1 Professions in technology

Profession (CONTEXT)	Rationale	Technology use	Possible example of working as a multidisciplinary team

The points you have included in Table 1.1 may have named other common 'high' technologies (digital devices) or the development of simple technologies (e.g. hook and eye). Technological processes such as cattle breeding or simple technologies such as a paper clip, or traditional technologies like digging sticks, are often not considered. Studies of student teachers, children and many Australian teachers have also shown that they too associate high technologies with the term technology

(Robbins and Babaeff, 2012). As such, only part of society is represented when high technologies are considered.

What is unique about technologies curriculum in Australia is the explicit mentioning of the broad range of technological contexts that are found in society for the strand Design and Technologies. The Digital Technologies strand does not list contexts – even though those discussed above (and below) connect to this strand. For example, in the Australian Curriculum – Technologies (ACARA, 2015), the following technological contexts are given, broadening our thinking about the professions associated with technologies. Perhaps some of the following came up in your list:

- engineering principles and systems
- food and fibre production
- food specialisations
- multimedia and technologies specialisations.

These contexts name the technologies in our society as recognised fields. But do children think about technologies in this way? We now turn our attention to what children think about technologies.

What do young children think about technology?

As part of the journey of thinking about what is technology and what is not technology, the perspective that children bring should also be considered. Children's thinking about technology is important to consider because their technological questions create engaging contexts for organising learning. Children want to know the answers to their questions. They want to know how their world works. But how can children engage with, and contribute to, their designed environment? For instance, in Figure 1.4 a child asks some important questions about an everyday object – a sticky tape dispenser.

How does sticky tape work?
What is sticky tape made from?
I think it is made of a piece of paper.
Why is one side sticky and the other side not sticky? And the other side is slippery?

Figure 1.4 How does sticky tape work?

Jarvis and Rennie used a picture quiz to identify Australian and British children's perceptions of the term 'technology'. The researchers asked children (aged seven and 11) to identify, from the following list of 28 items, which items had something to do with technology. Although this study was done some time ago, it still has relevance today. The list of items was:

- computer
- statue
- aeroplane
- factory
- volcano