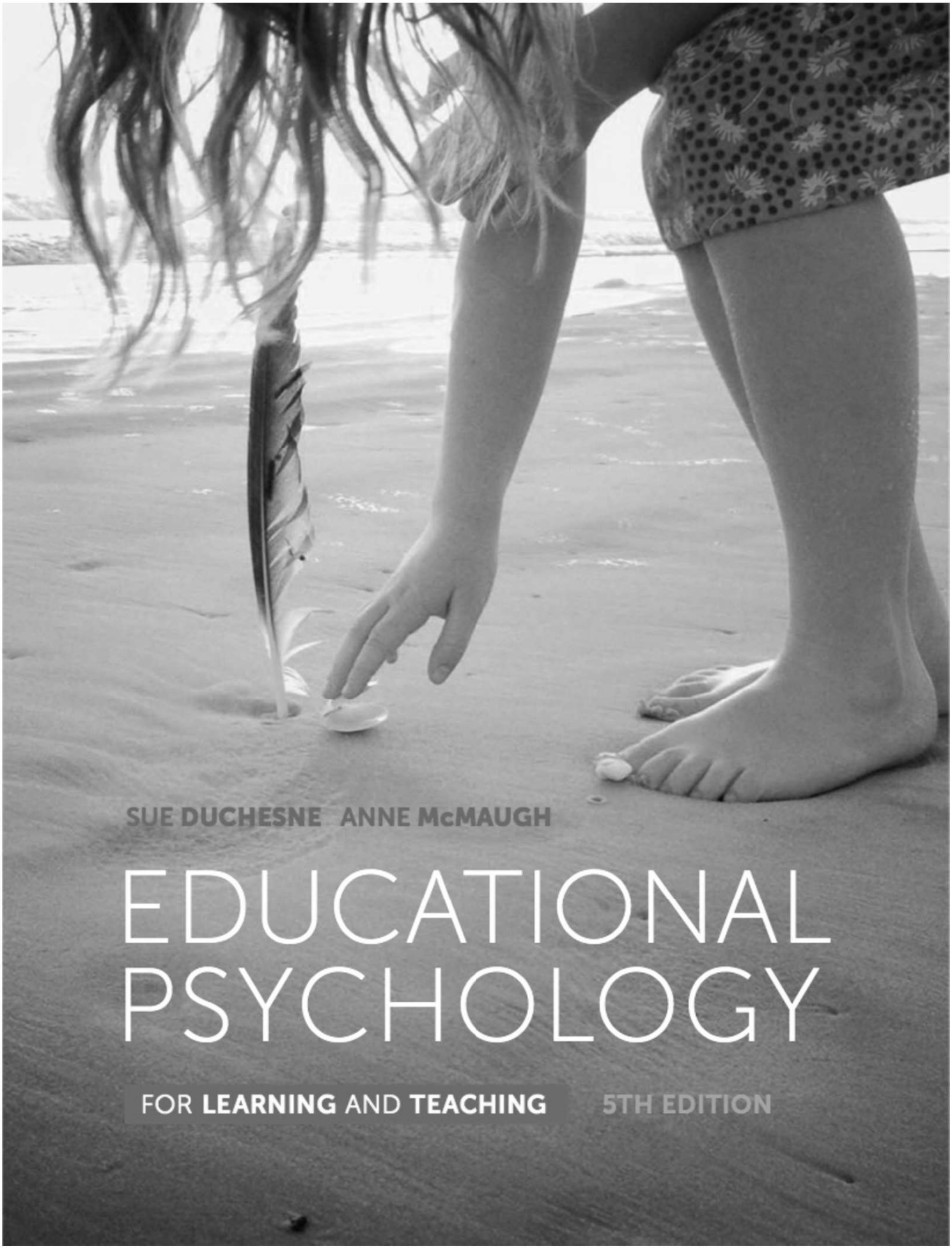

SUE DUCHESNE ANNE McMAUGH

EDUCATIONAL PSYCHOLOGY

FOR LEARNING AND TEACHING 5TH EDITION

Educational Psychology for Learning and Teaching
5th Edition
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Chapter 1

EDUCATIONAL PSYCHOLOGY FOR LEARNING AND TEACHING

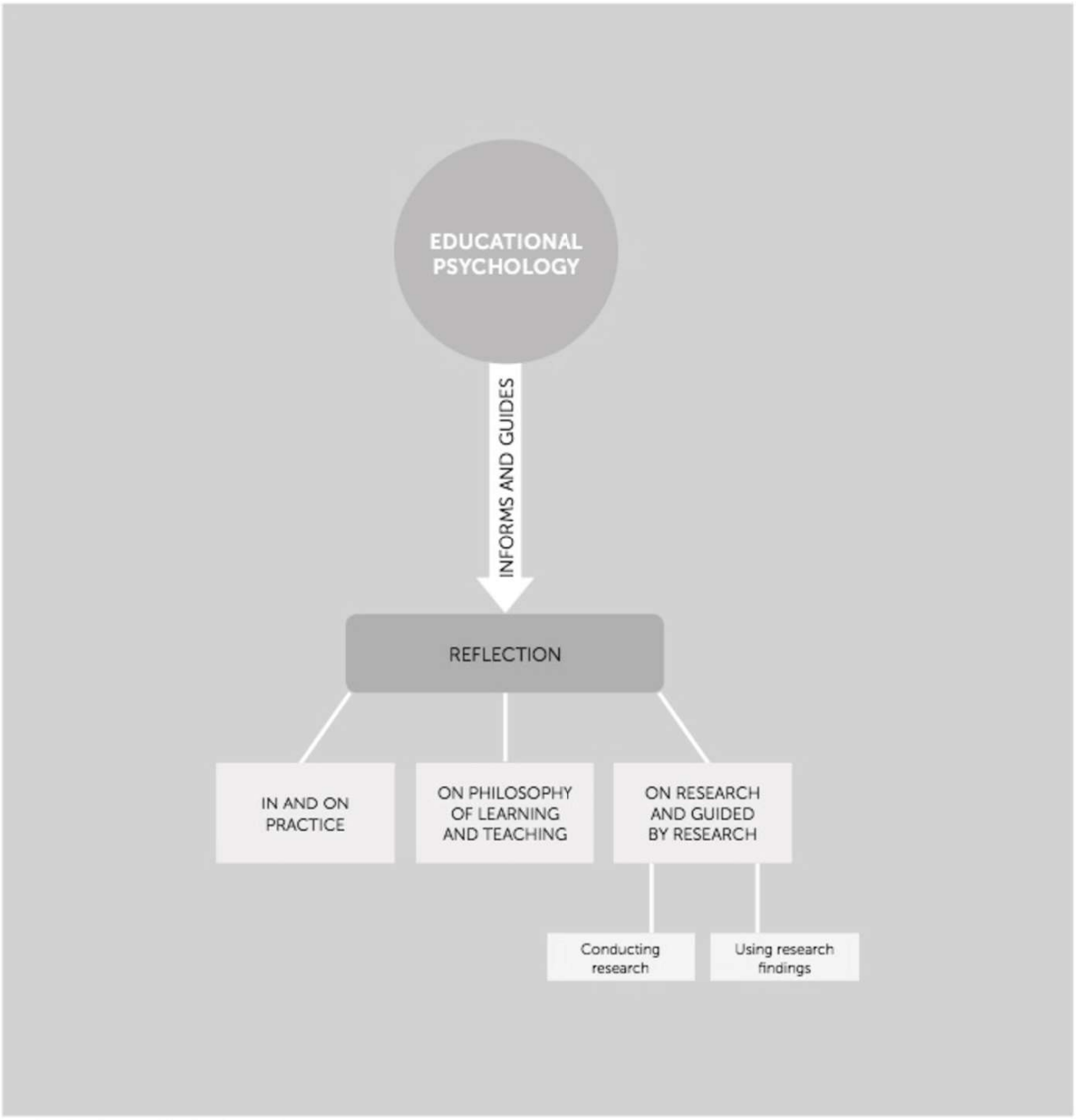

FIGURE 1.1 Chapter 1 concept map

KEY QUESTIONS

After reading this chapter, you should be able to answer the following questions:

- What is the purpose of educational psychology?
- How can educational psychology contribute to my development as a teacher?
- What is the role of reflection in teaching, and which tools will help?
- How can I use these reflective tools in quality ways to enhance my teaching?

INTRODUCTION

For many students using this book, the field of educational psychology – or 'ed. psych.', as you may soon call it – will represent uncharted waters. You may have chosen this area because you have always been interested in psychology, or perhaps you are studying to be a teacher and educational psychology is a compulsory subject. We hope that, whatever your reason for using this text, it will help you to develop your understanding and thinking about learning and teaching.

WHAT IS EDUCATIONAL PSYCHOLOGY?

Some students ask: 'Why not just simplify and call it *psychology*?' The reason is that **educational psychology** is a discipline in its own right, and connects the disciplines of education and psychology (Walberg & Haertel, 1992). It involves not only scientific research on the various dimensions of learning and teaching, but also the investigation of ways to apply psychological principles to educational contexts with the aim of enhancing learning and teaching quality.

educational psychology
A branch of psychology concerned with studying how people learn and the implications for teaching

One of the things students enjoy most about this subject is that, by studying theories of learning and development, they learn a lot about their own development and what influences their learning. A number of the effective teaching practices you experienced at school could be traced back to some element of educational psychology. As you read this book, you will begin to understand your own learning processes and how to improve them. You will also be challenged to think about ways in which teaching could be improved to cater for student differences and particular student needs.

WHO STUDIES EDUCATIONAL PSYCHOLOGY?

The discipline of educational psychology can be applied in many contexts. You may have taken up this book because you plan to be a teacher, and must study educational psychology as a foundation unit. Other readers may be psychology students who are interested in working with children or adolescents, whether in professional practice or as a counsellor in a school setting. Others may be preparing to be educational psychologists – qualified psychologists who specialise in applying their expertise in educational contexts, and who work in schools or other institutional settings (for example, university, government or corporate settings) where education takes place. Still others may be reading this text to better understand their own learning and the education process.

We recognise that the majority of this book's readers will be planning a teaching or related career. For this reason, our examples focus on early childhood, school-aged children and youth.

WHY STUDY ALL THOSE THEORIES?

It is true that when you first start studying educational psychology, you are introduced to many theories. Some educational psychology students have been heard to say: 'Ed. psych. is just a lot of theory … I came to uni to learn how to teach kids!' Our advice to you is to not lose heart and to remember that theories have an important purpose.

You will discover that theories form the foundation for understanding many critical issues that face learners and educators in the 21st century. Throughout this book, and particularly in the first half, we link theory to practice and encourage you to do the same. You will find that theories help us answer questions such as: What are the best ways of studying? How can I improve motivation – both mine and others'? Why do some young people give up on themselves, and what can I do about it? How can technology be used to enhance learning? Is education redundant in the information age?

Educational psychology and the theories of development and learning covered in this text will:

- help you understand your own development and factors that have contributed to it
- provide strategies to enhance the quality of your learning and motivation
- guide your understanding of how learners learn and how educators can become more effective in their teaching practice
- contribute to your personal philosophy of learning and teaching.

CHANGES IN THE EDUCATION LANDSCAPE

In the past few years, Australia has experienced major changes in policy and curriculum relating to schools and teaching, with the introduction of the Early Years Learning Framework (EYLF) in 2009, the *Australian professional standards for teachers* in 2011 and the Australian Curriculum in 2012. New Zealand also underwent changes to its assessment framework in 2011, and an expansion of Ka Hikitia, the Māori education strategy, into a second phase in 2013. You will find references to all of these documents in this edition of the text. Here, we consider how your study of educational psychology using this text might contribute to your development of knowledge towards the relevant teacher standards.

Educational psychology will contribute towards a number of elements of your professional knowledge, professional practice, and professional engagement. Table 1.1 provides an overview.

TABLE 1.1 Teaching standards and this text

CHAPTER	ELEMENTS FROM THE *AUSTRALIAN PROFESSIONAL STANDARDS FOR TEACHERS*	ELEMENTS FROM THE *GRADUATING TEACHER STANDARDS: AOTEAROA NEW ZEALAND*
	1 Know students and how they learn	**2 Know about learners and how they learn**
Module I: Chapters 2, 3 and 4	1.1 Physical, social and intellectual development and characteristics of students *Demonstrate knowledge and understanding of physical, social and intellectual development and characteristics of students and how these may affect learning*	2a Have knowledge of a range of relevant theories and research about pedagogy, human development and learning
Module II: Chapters 5, 6 and 7	1.2 Understand how students learn *Demonstrate knowledge and understanding of research into how students learn and the implications for teaching*	2a Have knowledge of a range of relevant theories and research about pedagogy, human development and learning
Module IV: Chapter 13		2b Have knowledge of a range of relevant theories, principles and purposes of assessment and evaluation
Module II: Chapter 6		2c Know how to develop metacognitive strategies of diverse learners

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CHAPTER	ELEMENTS FROM THE *AUSTRALIAN PROFESSIONAL STANDARDS FOR TEACHERS*	ELEMENTS FROM THE *GRADUATING TEACHER STANDARDS: AOTEAROA NEW ZEALAND*
		3 Understand how contextual factors influence teaching and learning
Module III: Chapter 11	1.3 Students with diverse linguistic, cultural, religious and socioeconomic backgrounds *Demonstrate knowledge of teaching strategies that are responsive to the learning strengths and needs of students from diverse linguistic, cultural, religious and socioeconomic backgrounds* 1.4 Strategies for teaching Aboriginal and Torres Strait Islander students *Demonstrate broad knowledge and understanding of the impact of culture, cultural identity and linguistic background on the education of students from Aboriginal and Torres Strait Islander backgrounds*	3a Have an understanding of the complex influences that personal. social and cultural factors may have on teachers and learners 3c Have an understanding of education within the bicultural, multicultural, social, political, economic and historical contexts of Aotearoa New Zealand
Module III: Chapters 9 and 10	1.5 Differentiate teaching to meet the specific learning needs of students across the full range of abilities *Demonstrate knowledge and understanding of strategies for differentiating teaching to meet the specific learning needs of students across the full range of abilities*	
Module III: Chapter 10	1.6 Strategies to support full participation of students with disability *Demonstrate broad knowledge and understanding of legislative requirements and teaching strategies that support participation and learning of students with disability*	
	2 Know the content and how to teach it	
Module I: Chapter 2	2.5 Literacy and numeracy strategies *Know and understand literacy and numeracy teaching strategies and their application in teaching areas*	
Module IV: Chapter 12	2.6 Information and communication technology (ICT) *Implement teaching strategies for using ICT to expand curriculum learning opportunities for students*	
	3 Plan for and implement effective teaching and learning	
Module II: Chapters 5, 6 and 7	3.2 Plan, structure and sequence learning programs *Plan lesson sequences using knowledge of student learning, content and effective teaching strategies* 3.3 Use teaching strategies *Include a range of teaching strategies*	
Module IV: Chapter 12	3.4 Select and use resources *Demonstrate knowledge of a range of resources, including ICT, that engage students in their learning*	
	4 Create and maintain supportive and safe learning environments	**4 Use professional knowledge to plan for a safe, high quality teaching and learning environment**
Module II: Chapters 5, 6 and 7		4a Use and sequence a range of learning experiences to influence and promote learner achievement
Module III: Chapters 8, 9, 10 and 11	4.1 Support student participation *Identify strategies to support inclusive student participation and engagement in classroom activities*	

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CHAPTER	ELEMENTS FROM THE *AUSTRALIAN PROFESSIONAL STANDARDS FOR TEACHERS*	ELEMENTS FROM THE *GRADUATING TEACHER STANDARDS: AOTEAROA NEW ZEALAND*
Module IV: Chapter 14	4.2 Manage classroom activities *Demonstrate the capacity to organise classroom activities and provide clear directions* 4.3 Manage challenging behaviour *Demonstrate knowledge of practical approaches to manage challenging behaviour* 4.4 Maintain student safety *Describe strategies that support students' wellbeing and safety working within school and/or system, curriculum and legislative requirements*	4f Demonstrate commitment to and strategies for promoting and nurturing the physical and emotional safety of learners
Module IV: Chapter 12	4.5 Use ICT (information and communications technology) safely, responsibly and ethically *Demonstrate an understanding of the relevant issues and the strategies available to support the safe, responsible and ethical use of ICT in learning and teaching*	
	5 Assess, provide feedback and report on student learning	**5 Use evidence to promote learning**
Module IV: Chapter 13	5.1 Assess student learning *Demonstrate an understanding of assessment strategies, including informal and formal, diagnostic, formative and summative approaches to assess student learning* 5.2 Provide feedback to students on their learning *Demonstrate an understanding of the purpose of providing timely and appropriate feedback to students about their learning* 5.3 Make consistent and comparable judgements *Demonstrate an understanding of assessment moderation and its application to support consistent and comparable judgements of student learning* 5.4 Interpret student data *Demonstrate the capacity to interpret student assessment data to evaluate student learning and modify teaching practice* 5.5 Report on student achievement *Demonstrate an understanding of a range of strategies for reporting to students and parents/carers and the purpose of keeping accurate and reliable records of student achievement*	5b Gather, analyse and use assessment information to improve learning and inform planning 5c Know how to communicate assessment information appropriately to learners, their parents/caregivers and staff
		6 Develop positive relationships with learners and the members of learning communities
Module III: Chapter 11		6a Recognise how differing values and beliefs may impact on learners and their learning 6d Promote a learning culture which engages diverse learners effectively
	6 Engage in professional learning	**7 Are committed members of the profession**
Chapter 1	6.4 Apply professional learning and improve student learning *Demonstrate an understanding of the rationale for continued professional learning and the implications for improved student learning*	7d Are able to articulate and justify an emerging personal, professional philosophy of teaching and learning

REFLECTIVE TEACHING

Students sometimes enter teacher education courses with the aim of discovering 'the best way to teach'. Researchers in educational psychology have also looked at what makes an effective teacher. In one international study, Clarke, Keitel and Shimizu (2006) researched the practices of competent teachers in 16 different countries, including Australia, and found that many different approaches were used. They also discovered that effective teachers drew on a variety of teaching and learning strategies. In line with their conclusions, we argue in this book that there is no one best way to teach, but rather that effective teaching is linked to making effective choices for yourself as a teacher, and about your subject matter and for your students. These may involve choices about curriculum content, learning and teaching strategies, methods of assessment and reporting, how to motivate students, catering for individual difference and classroom management. How do teachers evaluate whether their choices were good ones? Educational psychology can help.

THINK ABOUT

- What makes an effective teacher, in your experience?

Teaching can be described as a complex problem-solving activity. As such, research on effective problem solving and effective learning is applicable to teaching. In Chapter 6 you will see that effective learners are reflective about their learning, and have knowledge of themselves, the task they are undertaking and strategies they can implement. Planning, monitoring and evaluating are metacognitive (thinking about thinking) strategies employed by effective learners. In the same way, reflective teachers draw on metacognitive knowledge of self, task and strategies as they plan, monitor and evaluate their teaching.

Reflection has been described as important to quality teaching practice for some time. Dewey (1933) described reflection as a type of problem solving, and argued that reflection involves teachers in the important work of connecting their beliefs and knowledge to current actions and situations, potentially leading to the reframing of those ideas and beliefs, and more effective action. Schön (1983, 1987) coined the term 'reflective practice', focusing on the ways in which people think about their experiences and formulate responses as they happen ('thinking on your feet', which he called 'thinking in action'), as well as afterwards ('thinking on action'). In teaching, reflective practice occurs at all stages of the teaching process (see Figure 1.2).

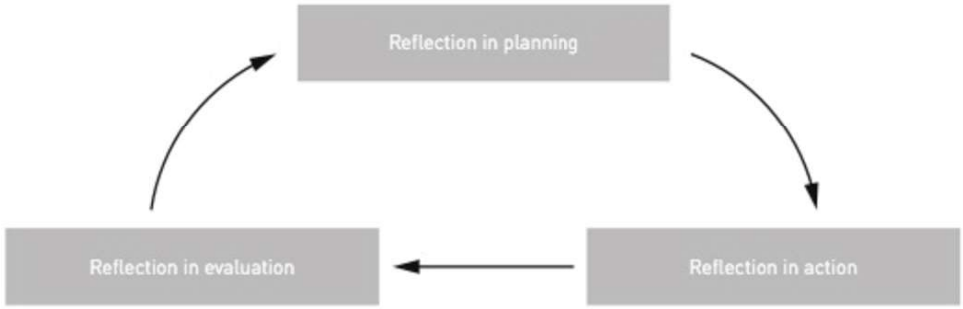

FIGURE 1.2 The cyclical nature of the reflective teaching process.

A number of researchers have developed typologies of reflection on teaching, distinguishing between several levels of reflection (for example, Lane, McMaster, Adnum & Cavanagh, 2014; Nelson & Sadler, 2013; Thorsen & DeVore, 2013). Collin, Karsenti and Komis (2013) caution that levels of reflection

should not be used to distinguish between reflection that is 'good' or 'bad', as what is most useful may depend on the circumstance. The following combines aspects from a number of the typologies to summarise the levels in broad terms:

1 At the most basic level, there is a *description* of what happened in the situation and its context (in Dewey's terms, this is not yet reflection); for example: 'The students were working in groups to solve an addition problem. Not all of the students participated in the groups, with some sitting back and letting others do all the talking'.
2 The next level adds some *evaluation* to the description; for example: 'In group work there's a range of participation. I need to make note of who does and doesn't participate, and think of how to involve them all in the learning'.
3 At a higher level, teachers *analyse* what happened in the situation; for example: 'I think in these group tasks some are silent but still thinking, one or two are dominating the thinking and talking, while others are being lazy and letting the rest of the group do the thinking. My setting up of group tasks will need to include strategies to ensure that all need to think, and that all can be heard'.
4 The highest level of reflection *integrates* the three previous tasks of description, evaluation and analysis, makes plans for proposed actions, and involves some kind of *reframing* of ideas, with reference to theory; for example: 'Group work helps some students to learn, while others do more learning in individual tasks. There may be a way of combining the two so that both sets of students are catered for in the one activity, but perhaps using a mix of individual, pair and group tasks would be best – both for optimum learning, and for inclusivity'.

Reflective teaching is informed teaching. Thus, reflection can draw on immediate experience, as well as theory and research in other settings, research in your own classroom (action research), discussion with colleagues, and feedback from students. The study of educational psychology is an important element that informs your reflection on your teaching.

This chapter outlines four main tools to help you become a more reflective practitioner, all of which draw on educational psychology. These are:

1 reflecting on your teaching practice
2 developing your personal philosophy of learning and teaching
3 using existing research to inform your practice
4 conducting research of your own.

REFLECTING ON YOUR TEACHING PRACTICE

critical reflection
Analysing what we are thinking and learning by questioning assumptions, perspectives and values related to our thoughts or to new information

Critical reflection involves analysing your own and others' thoughts and beliefs. It involves thinking about why people – yourself and others – behave in certain ways. When you reflect critically, you analyse and question existing knowledge and assumptions.

Reflection is a constant process, linked to practice. It can be supported by a range of activities, including reflective journals and portfolios, observation, and consulting with colleagues such as mentors or critical friends.

Keeping a reflective journal and portfolio

A reflective journal is written as a record of your experience with the purpose of examining and evaluating it. Portfolios extend this idea with the collection of work samples, lesson plans, worksheets and other artefacts of your teaching, accompanied by reflective commentary on the collection. Some prompts for reflection might be research reports, other professional reading, or discussions with colleagues. Here are some questions to guide your reflection on your teaching:

1 What are my goals for this class/this lesson?
2 How does what I do reflect those goals?
3 What are students responding well to?
4 What is not working? What are students responding poorly to?
5 What is frustrating me or the students?
6 Are my goals being met? Why or why not?
7 What does research and my professional reading tell me about what is happening or what should be happening in this class?
8 What have I seen or heard about in other classes that might be helpful?
9 What other goals do I need to focus on?
10 What new strategies do I need to explore?

Box 1.1 gives an example of one teacher's reflective journal.

BOX 1.1 CASE STUDY

ANNE'S REFLECTIVE JOURNAL

Anne was teaching a Year 8 French class. The following is from her Term 1 journal:

> I want to use immersion but it is too overwhelming for some students – they just give up. There is a wide range of abilities, with some students able to translate the cartoon with ease, and others with no idea of the basics (pronouns!). It's difficult for them to do exercises with minimal vocab, and for some, little understanding of how the language works. I think group work would allow the better students to move ahead while the beginners learn the basics. Will have to work on my classroom management skills for this to work. Spoke to [another teacher] about what she does with her German class. She has set formal grammar exercises for a small group of difficult ones who were way behind the rest of the class and very disruptive. Not sure how motivating this would be, but she says they are powering through them, and like the structure, and the idea that they can do it. Success is everything. Should look up the research on using immersion in Australia. I'm sure other teachers must have encountered this. Meanwhile for next lesson: set up activities with a series of exercises, stems on board, and some direct instruction. Small groups with cards in English (advanced students) or French (beginners) to complete the stems

Je veux ... or je ne veux pas ...	Je peux ... or je ne peux pas ...
Money for the show	Visit grandma
Buy clothes/a skateboard	Play at a friend's house
Do the washing up	Go to a movie
Go to Europe for the holiday	Stay at home

ACTIVITIES

Keep a journal of your ideas about teaching at present, and compare them with those you have at the end of your training, when you start teaching full-time, and several years hence.

Using mentors, critical friends and colleagues

Mentors are expert practitioners who take on a responsibility to share their skills and experience with a novice to help them to develop professional expertise. This may involve direct transfer of teaching skills, but it may also involve many other strategies: helping novices to reflect on their practice, or pointing them in the right direction to seek help, for example. Mentor programs may be formal or informal.

mentor
An expert practitioner inducting a novice into their profession

Many universities and education departments in Australia and New Zealand make use of mentors in teacher education and beginning teacher induction programs, and mentors are also seen at other levels of professional development, such as school leadership.

As well as expertise, there are a number of characteristics you may want to consider when choosing who you will approach to request a mentor relationship, thinking about someone who communicates well with you, is reflective, whom you trust, and who has expertise and a degree of match with your philosophy of learning and teaching. You are entering into a relationship that will involve demands on their time, and need to consider that as well. Is the person likely to have the time to listen to and talk with you, to come and watch you teach, and to reflect on your concerns? Possible roles mentors can fill include:

- emotional support
- professional support, including modelling, sharing of expertise and resources
- supervision
- critical evaluation, including provision of feedback
- reflection
- team teaching and collaboration (Hall, Draper, Smith & Bullough, 2008).

Given this range of roles, you may want to consider a number of colleagues: critical friends who can give you feedback on your ideas, a more senior colleague for advice, another teacher in your department with whom you can pair up to watch and comment on each other's lessons, and a friendly person who encourages you. All of this suggests a teamwork approach to teaching. Colleagues provide an important source of assistance and input for reflection.

Observation

CourseMateExpress

Online resources
Watch a **video** of a pre-service teacher reflecting on how she used some of the reflection activities during professional experience.

It can be helpful to observe your own class with fresh eyes, as well as observing others teaching. Aids to observation may include video and audio. Of course, you must gain the consent of your students to record them in this way, and make clear to them the purpose of the recording. McFadden, Ellis, Anwar and Roehrig (2014) reviewed a number of studies showing that observing and annotating video facilitated reflection, increasing depth of thinking, particularly when the process involved interaction with others. Additionally, you may choose to focus on certain behaviours you or your students are exhibiting. In this case, an anecdotal record or checklist may be useful. An anecdotal record is a simple description of an activity or event giving information on the setting of the activity, the individuals involved, what was said or done by whom, and the length of time involved. Such information is useful for analysing what is happening in a problematic situation, and for describing and defining specific behaviours. An example of an observation is given in Figure 1.5 (see page 17).

REFLECTING ON YOUR PERSONAL PHILOSOPHY OF LEARNING AND TEACHING

Studying educational psychology provides an ideal opportunity to develop the ability to reflect critically, and in so doing to develop a personal philosophy of learning and teaching. A philosophy is like a personal mission statement: it guides your choices, behaviours, thoughts and feelings. Whether you plan to teach in classrooms, work as a school counsellor, support your own children's learning or simply be a responsible and informed member of society, your personal philosophy will be central to what you believe, how you think and behave, and how you relate to others.

All of us have experience as learners, and possibly as teachers as well. As such, we come to the learning–teaching process with implicit theories, and preferences regarding learning and teaching. It can be helpful to examine that implicit knowledge, and to become aware of its origins. As you

study units in education, and gain further experience, your philosophy may well change. We hope, for example, that studying educational psychology will give you new insights into the learner, the learning–teaching process and some of the choices available to you as a teacher. With further teaching experiences, and deepening knowledge, your philosophy of learning and teaching is likely to continue to evolve. Developing a personal philosophy helps you to be aware of your beliefs, how they are related to your knowledge and experience, and the ways in which they can have an impact upon your learning and teaching. As a teacher, your philosophy should be informed by relevant theory and research in educational psychology. It will help you to set goals, make choices and evaluate your progress.

Here are some questions that might help you to start thinking about your personal philosophy:

- What does teaching involve?
- What (and who) has an impact upon learning?
- What is the role of the teacher?
- What makes an effective teacher?
- What is the role of the learner?
- What is learning?
- What makes an effective learner?

On the CourseMate Express website, you will find 'Develop your philosophy', which provides a space for you to consider your philosophy of learning and teaching related to each module of this text.

CourseMateExpress

Online resources
Take a moment to consider your personal philosophy. You may wish to use the **Develop your philosophy** tool on this text's CourseMate Express website.

USING RESEARCH AS A REFLECTIVE TEACHER

Research in educational psychology can assist the reflective teacher in several ways. First, it can be a source of new strategies or ideas for teaching. In studying this text, you may identify some ideas and strategies of which you were previously unaware. Second, research can help teachers to evaluate a number of choices in order to select the most appropriate one for their circumstance.

Research in educational psychology can also help teachers to make sense of their experiences by comparing them with others' findings and with theory.

John Hattie (1999, 2003, 2009) has conducted a number of meta-analyses, combining the results of thousands of studies to compare the effects of various factors on student achievement. He reported that student factors account for about 50 per cent of variance in achievement, while teachers accounted for about 30 per cent, and home, peers, schools and school principals each accounted for between 5 per cent and 10 per cent of achievement variance (see Figure 1.3). Hattie (2009) argued that beyond student ability, what teachers do in classrooms makes the greatest contribution to student learning, so it's important to think about how we evaluate what we do.

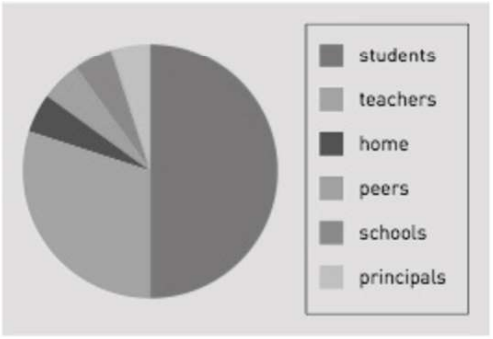

FIGURE 1.3 Percentage of achievement variance according to Hattie's research.

Hattie's research showed that almost all teacher interventions made some difference to student learning. This is in part because of the process of reflection the teachers go through in preparing, conducting and evaluating the program. This is a strong argument for research as a tool for reflection. Hattie argued that because the average effect size was 0.4, we should look for effects above this figure to identify truly effective interventions. His results are summarised in Table 1.2. You can explore many of the influences in the chapters of this book, as indicated in the table.

TABLE 1.2 What makes a difference to students' achievement? Comparison of effect sizes

BIGGEST EFFECTS	EFFECT SIZE	CHAPTER	SMALLEST OR NEGATIVE EFFECTS	EFFECT SIZE	CHAPTER
Piagetian programs	1.28	3	Programmed instruction	0.24	5
Classroom behaviour	0.80	14	Finances	0.23	11
Comprehensive interventions for learning disability	0.77	10	Class size	0.21	
Reciprocal teaching	0.74	3	Web-based learning	0.18	12
Feedback	0.73	13	Problem-based learning	0.15	6
Metacognitive strategies	0.69	6	Ability grouping	0.12	9, 10
Prior achievement	0.67	9	Gender	0.12	11
Creativity programs	0.65	9	Open versus traditional	0.01	7
Cooperative learning	0.59	6, 7	Summer vacation	−0.09	
Study skills	0.59	6	Retention	−0.16	10
Direct instruction	0.59	5	Television	−0.18	
Socioeconomic status	0.57	11	Mobility (changing schools)	−0.34	11
Quality of teaching	0.44	6, 7, 8			

Source: Adapted from Hattie, J. A. C., *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Published by Taylor & Francis Group, © 2009.

Reading and evaluating research

There is an enormous well of research in educational psychology from which to draw. Judging what is useful is an important skill for teachers to develop, as you will encounter numerous new approaches, theories and strategies in your practice. Hattie's rough guide of looking for effect sizes larger than 0.4 is one way to judge research studies showing an effect from a particular intervention. Other questions you might ask include:

- What evidence supports the theory, strategy or finding? Has it been researched? Is the research valid and reliable? Are the claims fully or only partially supported by the evidence? What other explanations of the research outcomes are there?
- Does it fit with other research in the area?
- Is it well supported by educational theory?
- What other views are there? Throughout this book, you will find presentations of different views on particular topics. By reviewing the research, you can make judgements about which view is best supported by the evidence, and perhaps identify what research still needs to be conducted.
- Where has the work been published? Is it only on the Internet? A vast amount of information on the Internet is very mixed in terms of quality and reliability. Research published in journals that have fellow academics review the articles submitted has been through a rigorous process before publication. Your university librarian can help you to locate appropriate journals for your area of interest.

CONDUCTING RESEARCH AS A REFLECTIVE TEACHER

The research process

Conducting your own research in educational psychology can give you an insight into the research process, as well as giving you direct answers to your own questions. It also helps teachers to integrate their experience with theory and previous research. The research process involves asking questions, informed

by prior research and theory, and then seeking answers to those questions through the collection and analysis of some kind of data. The conclusions drawn by the researcher about the meaning of the data are tested by reference to previous research and theory, and by presentation of the results for others to evaluate.

Figure 1.4 summarises the research process. Note that although this has been presented in a step-wise fashion, in reality, researchers may take a different path; for example, reframing a new research question after collecting interesting data, returning to design a second study linked to the first, or changing the research question if the original one proves unworkable to test.

CourseMateExpress
Online resources
Go further: See guidelines for writing a research report in Education on this text's website.

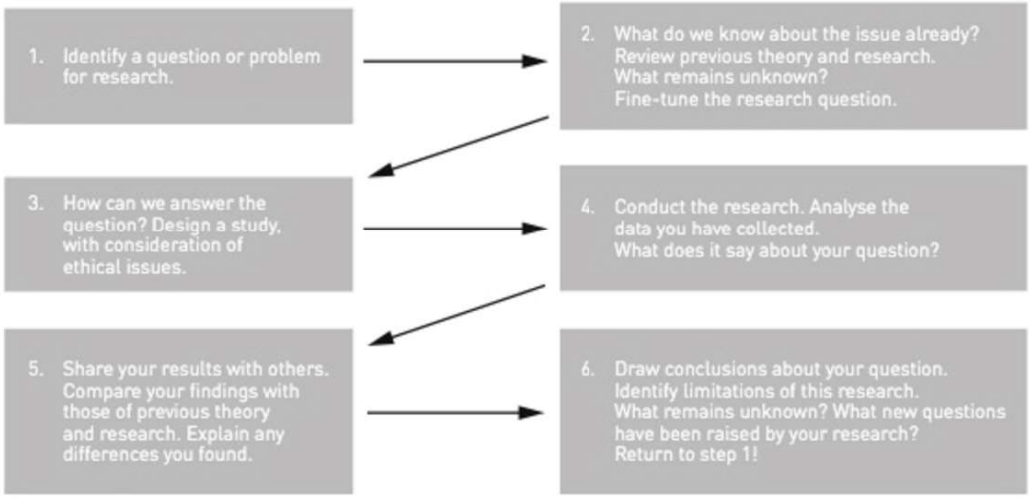

FIGURE 1.4 The research process.

CourseMateExpress
Online resources
Explore an example of a research report with the **Interactive Activity** on this text's website.

Action research

Action research is not confined to educational contexts but is undertaken by professionals across many spheres. It is defined simply as professionals investigating their own practice with the goal of improving it. It is therefore closely related to reflective teaching. The process of conducting action research involves the four steps of reflection, planning, action and reflection:

action research
Professionals evaluating their own practice with the goal of improving it

1 *Reflection*. Identify the issue you are concerned about. Develop some questions concerning this issue. Learn more about the issue by reading and consulting colleagues.
2 *Planning*. Develop a strategy.
3 *Action*. Take action – implement your strategy. Share the results with your students and colleagues. Action research is a collaborative process. Evaluate the evidence about the outcomes of your strategy.
4 *Reflection*. Revise your plans based on your evaluation. This restarts the cycle. An example of action research conducted by a teacher is given in Box 1.2.

BOX 1.2 RESEARCH LINKS

ACTION RESEARCH

Carlyn Sproston (2008) conducted an action research study in her Year 8 English classroom to investigate how involving students in negotiating their learning affected their motivation.

In the first cycle, students were asked about their perceptions of their English class through questionnaires and journal entries. They saw it as 'static and boring'. In particular, they didn't like the

>>

amount of writing and inactivity in the class. They then had a class meeting at which students' views were discussed and suggestions shared about what might make it more interesting.

The action that followed this was to start a unit on children's stories, which involved students analysing these stories and then writing their own. They visited a local primary school to read their stories to the children, and showed excitement and engagement in the activity. Students' journal entries at the end of the unit showed that they had enjoyed the narrative writing, particularly because it was a 'real' task. Carlyn's own reflection on the first cycle includes:

> As I reflected on the first cycle, I re-read some of the student journal entries. It seemed to me that the majority of the students had no idea of what to write; they just wrote what I asked for. When asked for their opinions about the activities, they wrote a word or a phrase and seemed to have no idea of how to evaluate their own work. However, when I interviewed students they were able to give me some opinions about the work, and what they thought about their own learning.

This led to a second cycle of action, in which Carlyn decided to build in some strategies to help students to evaluate their own work. Students developed informative pieces to present to the class. They had choice in their topic and the mode of presentation. They were given five guiding questions to support their evaluation of their work. Once again, the action was evaluated through students' journal entries and interviews, as well as Carlyn's own reflections. The students' evaluation was much more detailed. Another finding was that some students had found having a broad choice difficult, so that while ability to choose was motivating, they needed some boundaries within which to do this.

In the third cycle – a unit on school with students' work to be presented as a speech – Carlyn referred to work by Boomer (1992) and Reid (1992) on negotiated learning. Students were given the choice of topic, task, who they worked with and the audience, with the broader topic of school as the boundary. Students' journal entries indicated a real change from the attitudes to English they had expressed at the beginning of the year. They identified 'having a choice in learning activities; being involved and having a voice in the class; positive relationships with teacher and peers; variety and activity in their classes; collaboration and teamwork; having a real or authentic audience for their work; being committed to their work and to their class community; and having fun' as important elements that resulted from the negotiation of their learning.

Carlyn's final evaluation of the process concluded that there was greater motivation and commitment to learning from her students as a result of their involvement in the decision-making process.

Source: Adapted from Sproston (2008).

ACTIVITIES

1. Identify the steps in the action research cycle in this study.
2. Read the original article that relates the study in detail.
3. How is action research different from the reflection that teachers do in the course of their work?
4. Design your own action research study for a class you are involved in (it could be a school or a university class). You will need to negotiate this with everyone involved – teachers and students.

Approaches to data collection

In learning and teaching, a number of research methods can be useful for helping teachers to reflect on their practice. These include experimental approaches, interviews and observations. Researchers are careful to choose the appropriate method to answer their research questions or to test hypotheses.

A number of books are available describing methods of educational research in depth (for example, Cohen, Manion & Morrison, 2011).

1 *Experiment*. An experiment is a particular research technique involving the manipulation of one or more variables so that you can observe the result. In the classroom, you may wish to conduct an experiment to observe the result of a particular teaching strategy. In general, this requires two groups: one that received the treatment (were taught by the strategy) and another control group that did not. Use of a control group allows the researcher to test whether any effect found was a result of the treatment or whether it would have occurred anyway.
2 *Interview*. Interviews are useful for gaining insights into the views or thinking strategies of students, parents and teachers. For example, your students' feedback on your teaching (and their learning experiences) can provide powerful information to prompt your reflection. Some guidelines for collecting data through interviews are included in Box 1.3.
3 *Observation*. Observation was discussed above as a strategy for reflective teaching. It can also be a research tool. When observing in this context, it is useful to have a systematic way of collecting the data. For example, information can be organised in the form of a checklist, with data organised in segments of time, or by student behaviour, with the observational categories listed in the left-hand column and time units or student names listed across the top. An example is given in Figure 1.5, and an activity relating to observation is available on the CourseMate Express website. Observation can also be broader, noting elements of the context, activities and participants (teacher, learners) in the situation. Anecdotal records are a useful tool with which to collect information both about the broader situation and specific events. In either case, observation will be guided by particular research questions such as 'What is contributing to the observed outcome?' or 'How is this initiative affecting students' learning?'.

The observation record sheet in Figure 1.5 has as its focus student engagement in a lesson. It could be used to research student engagement in respect to particular lesson activities, timing in a lesson, and/or relationships in learning. Having more than one observer, and comparing their records, increases the reliability of the data.

BOX 1.3 IMPLICATIONS FOR EDUCATORS

GUIDELINES FOR COLLECTING DATA THROUGH INTERVIEWS

At the start of an interview, you need to establish rapport with the interviewee. Your aim is to give them the opportunity to tell you a little more about themselves.

- **Step 1:** Commence by telling participants there are no right or wrong answers.
- **Step 2:** As a way of making participants feel comfortable, ask them to tell you or write down a list of ways in which they learned or taught that day (or the day before). This will prompt them to think about the learning activities they engage in and how they feel about them.
- **Step 3:** Ask participants to elaborate and explain why they have given their answers. Remember to always ask participants to tell you why!
- **Step 4:** Now you can introduce the topic that you want to talk about in the interview.

Ideas for eliciting information

In order to promote discussion during the interview, you might ask participants to write down their ideas and let them think about them first, before they elaborate and tell you more. You can refer to each point on this list in turn as you progress through the interview.

Some interviewers also encourage participants (of all ages) to draw pictures or some form of visual representation, and then get them to comment on these in response to questions. You may wish to experiment with this technique. >>

It may also be helpful for you to use information from the literature to help develop your questions.

Using background reading to develop questions

Do plenty of background reading on the subject so that you are prepared to ask appropriate questions. You should tailor your reading and literature review to suit the subjects of your study if necessary. In other words, if you select an adolescent student, your literature review might look at research on adolescents.

Conducting interviews

Making sure you are well prepared is essential to conducting a successful interview. Devise a list of questions beforehand so you are familiar with them, and during the interview remember to adapt them, depending on the age of the interviewee. The set of questions does not have to be identical for each interviewee, but you should cover the same material so that you can compare and contrast answers.

Before you start the interview, take some time to get to know your interviewees (if necessary) and make sure they feel comfortable. Let them know that the purpose of the interview is to find out their views and opinions, and assure them there are no right or wrong answers. Also, make it clear that they are under no obligation to answer any question.

It is important to avoid any distractions during the interview. To this end, it is a good idea to record the interview (you will need to get ethics permission for this). Not only will this ensure you are able to focus completely on the interview, but it will be vital in preparing your transcript. Make sure your equipment is set up and ready to go so you don't need to attend to it during the interview.

Finally, try not to talk too much, and encourage the interviewees to talk. You may need to think of some prompts; for example, 'Can you tell me more about ...?', or 'Can you explain that a little more?'.

Keeping track of the interview

Some interviewers electronically record interviews, while others rely on written notes containing key points and quotes from participants. The transcript is then usually included as an appendix to the report.

In verbatim transcripts, there is no need to include 'ums' and 'aahs', but you should note any breaks or extended pauses in the interview. Body language or gestures may be noted in brackets if appropriate.

Ensure that your transcript does not contain the name/s of any schools, students or teachers. When interviewees mention names, you may include the first names only or make up pseudonyms. It is vital to maintain confidentiality throughout the report.

Quality considerations in research

If it's worth doing, it's worth doing well! In particular, researchers need to ensure that they collect information that can be trusted and that answers the questions, and that the conclusions they draw from it are reasonable, based on the information collected. The two key interrelated aspects of quality to consider in designing research are:

1 *Reliability*. This principle ensures that any findings would be found on another occasion under the same conditions. It avoids 'one off' results, and seeks to limit researcher bias. As a teacher, it is particularly important to protect against bias that might influence the results of your research. You can do this by using others to compare and confirm judgements made, and by collecting data from a range of sources or instruments.
2 *Validity*. This asks whether the research findings relate to what is claimed. For example, students' results on a reading test might be used to evaluate the effectiveness of a teaching strategy, but in

Class:	Lesson:	Date:	Time:

Record number of students engaged in each activity at time intervals of five minutes in a 50-minute block. Write the main activity of each phase of the lesson that corresponds to the time period being observed.

	Time									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Lesson activity:										
On task – independent										
On task – with peer										
On task – with teacher										
Off task – independent										
Off task – with peer										
Off task – with teacher										

FIGURE 1.5 Observation record sheet

fact students may have encountered other teaching strategies as well as the one under investigation, or the results may simply reflect students' reading ability rather than the effect of teaching. Validity can be strengthened by using established measures of the specific topic being researched, and by using a control group and randomly assigning participants to either group.

Ethical considerations in conducting research

When conducting research with humans or animals, a number of ethical guidelines must be followed. In Australia, these have been set down by the Australian Psychological Society (APS) and other bodies such as the National Health and Medical Research Council (NHMRC). Also, universities in Australia and New Zealand have ethics committees that check that research studies fulfil the appropriate guidelines.

Some of the issues to consider include:

- *Informed consent*. Information you must give includes a description of the research, its purpose and what participation would involve. Parents' consent must be obtained when conducting research with children.
- *Anonymity and confidentiality*. You should take every step to ensure that you maintain confidentiality. This means that you should not include participants' names or other identifying characteristics in any report you make of the results. You should also keep any records of the research in a secure place, to ensure privacy.
- *Voluntary participation*. Participants must be informed that their participation is voluntary, and that they can stop the interview or withdraw from the study at any time. This includes the right

to withdraw their permission for you to use their data. Participation should be entirely voluntary. Participants must not be pressured or coerced into participating in the research.

- *Sharing of results*. Your participants should be given a copy of any report of results and have it explained to them.

THINK ABOUT

- How can you ensure that your own students' consent to participating in your research is informed and voluntary?

ABOUT THIS BOOK

This book provides an introduction to educational psychology for learning and teaching, outlining key theories and research studies relevant to early years, primary and secondary education settings. It is organised in modules, with each module covering a particular set of relevant theories or issues.

- **Module I** focuses on child development, and starts with a chapter looking at some of the underpinnings of the skills you will see students display in schools. Cognitive and social, emotional and moral development are covered in the remaining chapters.
- **Module II** has learning as its focus, and is organised around the cognitive, behavioural and humanist approaches.
- **Module III**'s focus is individual differences, with chapters looking at motivation, intelligence, special needs and sociocultural differences.
- **Module IV** looks at the application of educational psychology to a number of key aspects of teachers' work: ICT, assessment and reporting, and classroom management.

Each chapter in this book has the following features:

- Concept maps at the start of each module and chapter illustrate the connections between key concepts.
- Key questions at the start of each chapter provide a broad outline of the chapter content. After you study each chapter, you can return to the list to check your understanding of each topic.
- Case studies help you to see the application of theory in practice within Australian or New Zealand classroom settings.
- 'Think about' panels throughout the text enable you to reflect critically on the processes of learning and teaching, and on your beliefs about these processes.
- Activities at the end of many boxed items give you the opportunity to apply your new knowledge.
- Self-assessment and discussion questions and activities detailed at the end of each chapter allow you to test yourself to see if you can connect theoretical concepts and real-world contexts.
- 'Putting it together' sections at the end of each chapter offer some possible links to material in other chapters that you can explore.
- Suggestions on recommended reading, online visits and education databases provide you with tips for further reading and research. The Search me! education database is a particularly helpful resource for assignments and wider reading.
- CourseMate Express icons throughout the book indicate where there are links to further examples, videos and activities on this text's website. These icons are also used to denote opportunities for you to 'Develop your philosophy'; that is, to consider your own position on the issues of learning and teaching raised in each chapter.

CONCLUDING COMMENTS

As you study educational psychology, we hope that you will develop your skills of reflection and critical inquiry, and that it will be helpful in broadening your understanding of learning and teaching. The material we cover in this book will be most meaningful to you if you see connections between theories and issues in the real world – and, in particular, links to your own learning and teaching experiences. The book contains four modules. The first two modules introduce you to theories of development and learning, which we encourage you to think about in relation to your own development and learning processes so as to understand practical applications. The third module is about individual differences that affect learning and teaching. The final module draws on these theories as the basis for discussing issues related to the learning–teaching process.

As you start reading, prepare to learn many new terms – especially in the first half of the book. Students often become discouraged because they forget what they have read and feel overwhelmed. The key is to deal with small chunks of new information at a time. Talk with fellow students and with your lecturer or tutors about the most effective ways to learn and revise this material. Return to the questions at the start of each chapter to check your understanding. Usually, as students become more familiar with educational psychology and with discussing its application in the classroom or other contexts, they start to see connections. At the end of each module, a summary table makes links between or compares key content in each chapter. Take some time to review the relevant table as you finish a chapter, to help you connect ideas as you go, and to build your own philosophy of learning and teaching, guided by research.

CHAPTER REVIEW

- Educational psychology is the application of psychological principles to the study of learning and teaching.
- Studying educational psychology can contribute to your understanding of yourself as a learner and teacher, as well as of your students, and to your understanding of the learning and teaching processes themselves.
- Effective teaching is linked to making effective choices, and educational psychology can help to guide teachers in both making and evaluating their choices.
- Educational psychology informs and deepens reflection on teaching practice.
- Tools for critical reflection include reflective journals, portfolios, mentors and observation.
- Developing a personal philosophy of learning and teaching can guide choices; provide insights into your own behaviours, thoughts and feelings; and reveal implicit knowledge and theories you bring to your practice.
- Using existing research can inform practice, provide new ideas for teaching, evaluate choices and make sense of experiences.
- Conducting research involves asking questions, and seeking answers to those questions. Methods include experiment, interview and observation.
- Action research links reflection on teaching to research. It involves a cycle of reflection, planning and action.
- Research quality is determined by validity and reliability, as well as ethical considerations such as confidentiality, informed consent and voluntary participation.

ONLINE STUDY RESOURCES

COURSEMATE EXPRESS

Visit http://login.cengagebrain.com and use the access code that comes with this book for 12 months' access to the student resources for this text.

The CourseMate Express website contains a range of resources and study tools for this chapter, including:

- a **self-check quiz**
- **crosswords**, **flashcards** and a **glossary** to help you revise the key terms from this chapter
- the **Go further** materials and **interactive activity** mentioned in the chapter.

SEARCH ME! EDUCATION

Explore Search me! education for articles relevant to this chapter. Fast and convenient, Search me! education is updated daily and provides you with 24-hour access to full-text articles from hundreds of scholarly and popular journals, ebooks and newspapers, including *The Australian* and *The New York Times*. Log in to Search me! through http://login.cengagebrain.com and use the search terms listed in the 'Education databases' section (page 21) as a starting point.

QUESTIONS AND ACTIVITIES FOR SELF-ASSESSMENT AND DISCUSSION

1 List some ways in which educational psychology can guide teacher reflection.
2 Identify strategies teachers can employ to reflect on their teaching, and students' learning.
3 What makes for quality research? What issues should be considered?
4 Reflect on your past experience (if any) as a participant in a research study.
   a How were you informed of the purposes of the research and your role in it?
   b How was your voluntary consent obtained?

KEY TERMS

action research | critical reflection | educational psychology | mentor

PUTTING IT TOGETHER

MAKING LINKS BETWEEN 'EDUCATIONAL PSYCHOLOGY FOR LEARNING AND TEACHING' AND MATERIAL IN OTHER CHAPTERS

- 'Research links' boxes in each chapter give examples of research studies. Consider the different approaches used.
- See Chapter 13 for more on reliability and validity.
- See Chapter 13 for more on observation and interview in relation to student assessment.
- There are opportunities throughout the book for you to reflect on and develop your philosophy of learning and teaching.

FURTHER RESEARCH

RECOMMENDED READING

Cohen, L., Manion, L. & Morrison, K. (2011). *Research methods in education* (7th ed.). Abingdon, UK: Routledge.

Larrivee, B. (2000) Transforming teaching practice: Becoming the critically reflective teacher. *Reflective Practice: International and Multidisciplinary Perspectives*, *1*(3), 293–307.

Stringer, E. T. (2014). *Action research*. Thousand Oaks, CA: Sage.

RECOMMENDED WEBSITES

Australian Institute for Teaching and School Leadership: www.aitsl.edu.au/australian-professional-standards-for-teachers
This website also has illustrations of practice in each of the various standards.

New Zealand Teachers Council: www.teacherscouncil.govt.nz/content/graduating-teacher-standards

EDUCATION DATABASES

Search databases such as ERIC, PsycINFO and the Australian Education Index, using terms such as:

- action research AND teaching
- mentoring AND teaching
- reflective practice AND teaching

You can also use these terms as a starting point for exploring the **Search me! education** database mentioned above.

Module

1

THE LEARNER DEVELOPING OVER TIME

MODULE CONTENTS

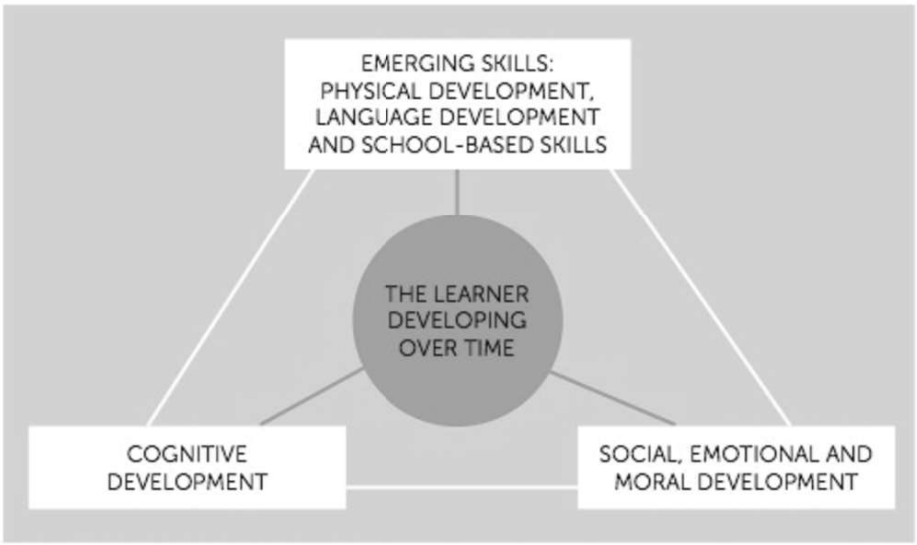

FIGURE MI Module I concept map.

Core question: How can theories of development enhance the understanding of learning and teaching?

Human development occurs in many areas: physical, cognitive, social, emotional and moral, to name a few. None of these aspects of development occurs in isolation. To understand the learner as a whole person, you need to see the interconnections between the different facets of development and the ways in which these contribute to the emergence of a complex but integrated individual.

Although genetic influences on development are significant, the role of social and cultural factors is receiving increasing attention. In this module, you will notice the use of the prefix 'socio' in words such as 'socioemotional', 'sociocultural' and 'sociomoral', to highlight social influences on development.

The three chapters in this module highlight the learner's complex and multidimensional nature. In Chapter 2 we explore the physical and linguistic dimensions of development, including brain development, and how these relate to learners who are developing the basic skills of literacy and numeracy. Chapter 3 focuses on the learner's mind and the ways in which thinking and reasoning develop over time. Chapter 4 examines what makes the learner unique – the self – and how thinking about the self and others develops as cognitive processing abilities become more complex. We also examine the relationship between cognitive, social and emotional development, the capacity for moral reasoning and the development of values and beliefs.

Recognising how developments in one dimension support and contribute to developments in other areas helps teachers consider all aspects of their students' lives in order to design appropriate learning and teaching experiences. In each chapter of this module, we encourage you to consider how teachers can adapt their teaching to cater for the varying developmental needs of students.

Chapter 2

EMERGING SKILLS

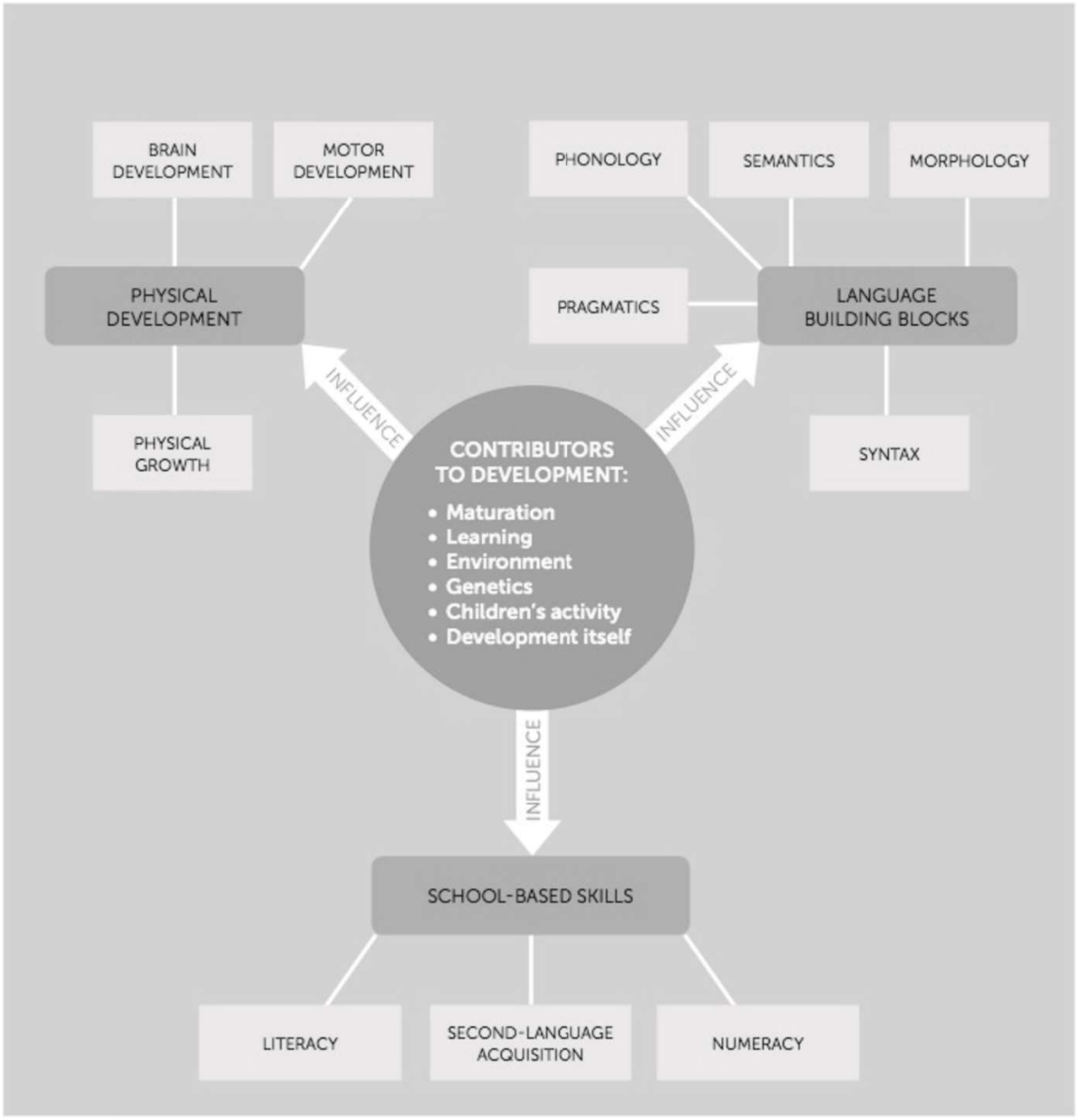

FIGURE 2.1 Chapter 2 concept map

KEY QUESTIONS

After reading this chapter, you should be able to answer the following questions:

- What are some milestones of physical development from early childhood to adolescence?
- How are physical development, language development and school skills connected? Give examples of the relationships between them.
- How do developments in the brain over time explain the broad patterns of development seen in physical, language and school skills?
- Broadly describe the course of language acquisition. What influences it?
- How does the teaching of literacy and mathematics build on earlier developments?
- What are some key principles of development?

INTRODUCTION

As a young child starts to crawl and to walk, these physical developments lead to others in thinking, language and social relations. As an adolescent enters puberty, this physical milestone has consequences for their emotional and social development. Those same children starting school, and young people starting high school, experience changes that influence language, cognitive, social and emotional development. Development is influenced by multiple factors, some of them environmental, and others internal to the child. Development in one domain shapes and is influenced by development in others. As we look at development in some key domains in this chapter, this and a number of other principles of development will unfold. These are summarised for you at the end of the chapter.

Source: Matthew Duchesne, © Milk and Honey Photography, 2010

FIGURE 2.2 Each child brings skills to school with them. What influences their development?

PHYSICAL DEVELOPMENT OVER TIME

As we explore development in this chapter and throughout Module I, we look at four phases of the child's life: 'infancy' (the first two years), 'early childhood' (from three years old until seven years), 'middle childhood' (from seven years old to adolescence) and 'adolescence' (about 12 years old to adulthood). Development does not stop at adolescence, of course, but continues throughout the lifespan. This text focuses mainly on the school years: early and middle childhood, and adolescence.

PHYSICAL DEVELOPMENT IN INFANCY

Physical development sometimes seems to happen without our noticing. Yet the physical developments of childhood – changes in growth, in motor skills, and in the structure of the body and the brain – form an important basis for developments in cognition (thinking) and emotion.

Consider a newborn baby. Right now she has no control over her movements, yet within 18 months she will be walking, in another year running, and soon after jumping and throwing and kicking balls. In the first two years, children develop physically at a faster rate than at any other time in their lives. Although we do not describe infants' physical development here in any detail, it forms an important basis for children's development – not just physical, but also social, emotional and cognitive – in later years.

Physical development, cognition and emotion

An infant's shift from staying in one place to independent mobility is a change with consequences parents are rapidly aware of – suddenly the whole house seems to need to be rearranged to keep the baby safe … and to keep the household items safe from his reach! This shift in physical development also has consequences for the child themselves, with increased opportunities to explore the environment through crawling, as well as the physical work of crawling itself linked to improvements in visual perception, wariness of heights, spatial search strategies and brain development (Anderson et al., 2013).

What about infants who are unable to crawl because of disabilities? Or infants from cultures in which children are discouraged from crawling because of environmental dangers? There may be some effects on other domains of development. For example, it appears that there is a delay in spatial search for infants whose crawling is delayed (Campos et al., 2000). However, lack of crawling may only delay its development, not prevent it entirely. In addition, crawling is not invariably linked to spatial search, so it can be said that crawling is neither necessary nor sufficient for this cognitive ability to develop. This relates to another principle of development: there are more likely to be multiple pathways to development, rather than a common one for all individuals.

With walking comes another shift in development, as the child's line of sight moves forward and upward, rather than being directed largely at the floor and lower walls when crawling (Kretch, Franchak & Adolph, 2014). Language development is affected as the child interacts with their environment in new ways, prompting parents to respond by talking about their environment, building vocabulary. Walking infants are also reported by parents to be more independent, which relates to their socioemotional development (Walle & Campos, 2014).

The close relationship between physical, cognitive, social and emotional development is one that persists throughout development. As you read this chapter, try to look for more connections between the development of one skill and others. There are other connections, too, with later development building on what has gone before. In infancy, children are already developing the physical, cognitive and emotional bases for the skills they will use at school.

THINK ABOUT

- Consider other times when reaching a developmental milestone might prompt development in other domains. What does this reveal about how the domains of development are interrelated?

PHYSICAL DEVELOPMENT IN EARLY CHILDHOOD

Although the rate of physical growth slows in early and middle childhood, age brings further increases in children's size, strength and coordination. This development of children's muscle strength, plus improved balance and coordination, along with a lower centre of gravity, brain maturation and children's activity

itself, all support the development of children's motor skills (Adolph & Berger, 2010) (see Figure 2.3).

Motor-skill development in early childhood

Gross motor skills are those skills involving large muscle groups and often whole-body movements such as rolling, jumping, clapping, throwing and running. **Fine motor skills** are skills involving smaller muscle movements, usually of the hands and fingers, and include grasping and manipulating pencils or scissors. As children's development progresses and their control becomes increasingly refined, they move from requiring large pieces of paper on which to work, and large implements with which to write, to being able to write with a variety of pens and pencils between ruled lines on a page.

Source: Matthew Duchesne, © Milk and Honey Photography, 2010.

FIGURE 2.3 A shift in the centre of gravity, together with increased strength, balance, coordination and flexibility, contribute to improvements in running skill that occur with age.

Acquisition of motor skills is one of the main developmental tasks of early childhood, and for this reason most preschool and early-school programs in Australia and New Zealand attach great importance to it. Climbing over obstacle courses; rolling, throwing and catching balls; and running, jumping, hopping and skipping all help to develop gross motor skills. Likewise, using dough, clay, crayons and paint, and activities that involve crumpling, cutting or tearing paper, all contribute to fine motor-skill development (see Figure 2.4).

gross motor skills
Movement skills using large muscle groups

fine motor skills
Movement skills using small muscle groups

Source: Matthew Duchesne, © Milk and Honey Photography, 2010.

FIGURE 2.4
Children's activities in early childhood help to develop gross and fine motor skills. What skills are being developed here?

Motor-skill development is also controlled by neurological growth. As the speed and efficiency of information processing improves (see later in this chapter and in Chapter 3), this enables children to intentionally control and combine movements (Adolph & Berger, 2010).

Parents contribute to motor-skill development at home through undertaking everyday activities with children, such as going to the park for a swing, drawing and doing puzzles. In some communities, motor skills are developed through community or traditional activities, as well as in formal preschool contexts. In the Torres Strait region of Australia, for example, Indigenous children's motor skills are developed through involvement in community dances from the time they can walk. The dances are taught more formally at school, which refines these skills (J. Davis, personal communication, 2001). Likewise, Māori communities in New Zealand develop *te reo kori* (the language of movement) within *ngā mahi a r-ehia* – Māori recreational and leisure activities such as *poi*, *rakau* and *whai* (New Zealand Ministry of Education, 2007).

Children's spontaneous activity also contributes to their motor-skill development. The seemingly constant movement of preschoolers has a purpose in developing their gross motor skills, strength, coordination and sense of balance. Children also benefit from such activity in other ways, since (as we have seen) motor and cognitive development are related. The contribution of motor activity to cognition continues beyond the early years, influencing later academic skills such as reading and calculation. Box 2.1 describes further the relationship between physical activity and cognition.

BOX 2.1 RESEARCH LINKS

EXERCISE AND COGNITION

Best (2010) reviewed the research literature examining links between aerobic exercise and children's goal-directed cognition or executive function (see Chapter 3 for a description of the development of this aspect of cognition). He reported that single bouts of exercise and also more extended exercise programs had been shown to increase children's cognitive skills related to executive function. These skills include inhibition (the ability to selectively attend to a stimulus, ignoring others), shifting (the ability to shift between cognitive tasks) and creativity. Davis et al. (2011), working with overweight children, found that aerobic exercise also improved their achievement in mathematics, even when the children received no specific instruction in mathematics.

Best suggested several explanations for the links. Exercise is often cognitively demanding – we are using executive function, for example, when working with a team, or judging where to move to in order to intercept a ball in soccer. The cognitive skills that are developed through physical activity are then available for purely cognitive tasks. Coordination of motor movements that develops in middle childhood also involves executive function, and may be a contributor to brain development in the particular areas of the brain involved in executive function (addressed later in this chapter). Chemicals released in the brain during exercise also contribute to cognition – so exercise shows benefits for cognition in the short and long term.

The strength of the relationship between physical exercise and cognition underscores the importance of physical activity as a part of the school day. This may happen through structured lessons as well as in school break times. Parrish and colleagues (2009, 2012) have explored factors in primary school environments that influence children's physical activity levels in the playground. They found that longer break times, access to non-fixed equipment, ball play, and environmental aspects such as unshaded areas, painted targets and soft play surfaces all contributed to increases in children's physical activity.

ACTIVITIES

1 What place should physical activity have in the school curriculum? Develop a recommendation for a school to maximise children's physical activity during the school day.
2 How would you encourage students who are reluctant to be physically active at break times?

PHYSICAL DEVELOPMENT IN MIDDLE CHILDHOOD

Continued increases in size, strength, flexibility and coordination during the school years enable children to master the skills involved in sports. However, rather than learning entirely new skills – as occurs in early childhood – the task now is to refine and recombine existing skills to suit new challenges. Consider as an example the running, turning and kicking involved in playing soccer; or the running, throwing and catching required in netball. The jumping and chasing games and ball throwing and kicking done in early childhood are precursors of the advanced skills that are combined in specialised ways to play each sport. Younger children may be able to jump, hop, run, turn and throw a ball in isolation, but being able to combine these skills is a new achievement of the middle-childhood years. The ability to coordinate motor skills, such as in eye–hand and foot–hand coordination, is a significant development of middle childhood.

Motor-skill development in middle childhood

Children's playground games such as hopscotch, skipping, elastics, chasing, handball and jacks all contribute to the development of motor skills during the middle-childhood period.

Source: Cameron Spencer/Getty Images

FIGURE 2.5 Children's physical activity contributes to cognitive, social and emotional development.

Swimming, riding bikes and scooters, and similar activities enjoyed by children in their leisure hours are also important. In addition to contributing to motor-skill development, links have been made between physical activity and *social outcomes*, such as the learning of social skills and reduced isolation; *emotional outcomes*, such as reduced depression, anxiety and stress, and increases in self-esteem and confidence; and *cognitive outcomes*, such as concentration, memory and learning (Commonwealth of Australia, Department of Health and Ageing, 2005). Two reviews of research found a positive relationship between physical activity and academic achievement (Singh et al., 2012) and academic skills and behaviours such as attention, memory and on-task behaviour (Centers for Disease Control and Prevention, 2010). Links have also been found between exercise and neuroplasticity, explained later in this chapter (Hötting & Röder, 2013).

One of the concerns expressed about the amount of time children spend watching television or playing computer games is the time that these activities take away from more active pursuits. Adolph and Berger (2010) stated that sedentary activity is more likely to account for overweight and obesity rates than will overeating. A large study of Australian children revealed that 74 per cent of children met the physical-activity guidelines of at least one hour of moderate-to-vigorous physical activity each day, but only 33 per cent met the guidelines for screen time, which is to spend no more than two hours per day in viewing television, video or computer screens (AIHW, 2009). New Zealand figures are similar, with 67 per cent of children and young people meeting physical-activity guidelines, and 40 per cent meeting screen-time guidelines (Clinical Trials Research Unit, 2010). These percentages are averaged across the entire population of either Australia or New Zealand, with poorer results for older than for younger children, for those from low socioeconomic backgrounds, and for some ethnic groups. Participation rates are higher when parents regularly participate in a physical activity (Australian Sports Commission, 2012). The Australian Sports

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Online resources
Watch **videos** of children of different ages running on this text's website.

Commission (2004) reported screen time as a major competitor with physical activity for children's time. The commission also attributed the decline in physical activity to factors such as concerns for children's safety, modern street design, less play space, smaller home blocks, longer working hours of parents and a general disintegration of neighbourhood social networks, all of which restrict opportunities for free play.

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Online resources
Go further: View the Physical Activity Guidelines via the link on this text's website.

Physical education forms an important part of school curricula in Australia and New Zealand, with the New Zealand Ministry of Education (2004) setting a priority on physical activity in the *National education goals*, and the Australian Government recommending at least one hour a day of vigorous physical activity for children and young people (Commonwealth of Australia, Department of Health, 2011a, 2011b). In addition, the Australian Sports Commission in 2005 initiated an after-school program that encouraged physical activity and provided opportunities for ongoing sports participation. Entitled *Active after-school communities*, it involved over 3000 school communities across Australia, and had seen 190 000 children participate by the end of 2010 (Australian Sports Commission, 2011).

PHYSICAL DEVELOPMENT IN ADOLESCENCE

During adolescence, physical growth resumes the rapid pace of growth in infancy. The hands, feet and legs are the first to increase in size, which sometimes results in a 'coltish' look and in clumsiness. The trunk of the body lengthens last, bringing adolescents to adult body proportions (Berk, 2012). These developments are accompanied by significant muscle growth – although this is greater in boys than in girls, for whom there is a 40 per cent increase in body fat. These sex differences result in the different body shapes of adulthood, with men generally leaner and more muscular than women.

Sex differences in adolescent development

adolescence
The period between childhood and adulthood

puberty
The biological changes associated with sexual maturity

Often, the terms **adolescence** and **puberty** are used synonymously, but they are not the same thing. The period of adolescence is usually associated with the teen years (ages 13 to 19) but may be defined as the period between childhood and adulthood. Thus, in Western societies, adolescence can stretch from 11 to 21 years and is typically defined in terms of age and social circumstances. Puberty, however, is defined by physical changes, specifically the physical and biological changes associated with sexual maturity. Puberty generally occurs during adolescence but may start some years earlier than the age of 13, particularly in girls in industrial societies. Puberty tends to be completed within four years; adolescence, however, may last from six to 10 years and tends to be longer in industrial societies, where young people are often engaged in education for long periods before they are truly independent of their parents (Cote & Allahar, 1996).

In girls, puberty is signalled by rapid increases in height and weight, which trigger the onset of 'menarche', or first menstruation. This is accompanied by other physical changes that are related to reproduction, including breast development (which precedes menarche), and the enlargement of the uterus and the appearance of pubic hair (which usually follow menarche).

In boys, sexual maturity starts with changes to the testes and scrotum, followed by the appearance of pubic hair and then growth of the penis. Increases in height generally occur later in boys' developmental patterns than in those of girls, which explains why girls may be taller than boys in the early years of high school. 'Semenarche' (or first ejaculation) commonly follows the height spurt in boys, just as menarche does in girls. Other changes associated with the later stages of puberty for boys include the growth of facial and body hair, and the deepening of the voice as

the larynx lengthens. This can initially cause boys some embarrassment as the voice 'breaks', with sudden changes in pitch.

Connections among physical, cognitive and socioemotional development in adolescence

The dramatic physical changes of puberty are accompanied by social, cognitive and emotional changes. One of the most significant results of physical changes is a concern with body image. A feeling of 'not fitting' the new taller body with its bigger hands and feet may bring self-consciousness for boys, while girls may become dissatisfied with their increased weight and body fat that do not match the 'ideal' body image promoted in the media. Recent studies, however, showed that comparison with peers has a greater role than the media (Carey, Donaghue & Broderick, 2014), which may suggest social media's role in the process.

Australian and New Zealand studies of body image and dieting behaviour have shown that dieting and dissatisfaction with body image are widespread, and are greater among girls than boys. The New Zealand Ministry of Health (2012) reported on a 2007 youth survey that showed just 36 per cent of girls and 44 per cent of boys were happy or very happy about their weight, while 48 per cent of these young people were trying to lose weight and 14 per cent were trying to gain weight. There were variations across different ethnic groups, with more Māori, Pasifika and Asian youth positive about their weight compared with European young people in the study. There were gender differences, too, with more girls reporting they were trying to lose weight and more boys trying to gain weight.

In some girls, this widespread pattern develops into eating disorders such as compulsive eating disorder, anorexia and bulimia. Chapter 4 discusses eating disorders in more detail. If teachers or parents suspect a child of having an eating disorder, it is important that they consult an expert, as these illnesses are complex, difficult to treat and have potentially severe outcomes.

The timing of puberty appears to affect how adolescents cope with developmental changes, as well as with others' reactions to these changes. Adolescents who mature 'on time' fare best, with early maturing girls at greater risk for social anxiety, depression, substance use and deviant behaviour (Ge & Natsuaki, 2009), while boys can experience depression, anxiety and problematic behaviour from either early or late maturing (Negriff & Susman, 2011). A number of explanations have been given for these effects, including the possibility that with early maturation, girls may seek peers similar to themselves, exposing them to older peers and risky behaviours before they are emotionally ready to evaluate the risks (Stattin, Kerr & Skoog, 2011). Stattin, Kerr and Skoog reported that the context (such as school) can moderate this exposure to older peers. Boys can also experience effects from early or late maturing, with White, Deardorff, Liu and Gonzalez (2013) finding that early-maturing boys experienced problems with anxiety and behaviour. Cultural norms amplified the effects on the Mexican boys in their study, who fared better in communities with concentrations of people of like ethnicity. The link between physical and emotional development here is evident but complex: there is considerable scope for individual difference in outcomes depending on context, level of support and personality factors.

In this section we have looked at variation within groups of boys or girls. In the next section, we consider variations in physical development among groups. Box 2.2 summarises the developmental trends we have discussed, and links them to contributions made by brain and body development and children's behaviour. It then gives some suggestions for ways in which the teacher or parents can contribute to development at each stage.

BOX 2.2 IMPLICATIONS FOR EDUCATORS

CONTRIBUTING TO MOTOR DEVELOPMENT

	MOTOR DEVELOPMENTS	CONTRIBUTIONS OF BODY, BRAIN AND BEHAVIOUR	WHAT TEACHERS AND PARENTS CAN DO
Infancy 	Sitting independently Crawling Walking	*Body:* Changes in body proportion contribute to balance, stability and increased strength; greater muscle-to-fat ratio in legs and stronger back and hip muscles allow weight bearing. *Brain:* Increases in processing speed and efficiency allow infants to combine movements, and to control them. *Behaviour:* Exploration is both a motivation for and a consequence of greater mobility; practice contributes to strength, balance and visual-motor learning.	Encourage exploration, which motivates crawling, walking and reaching behaviour. Child-rearing routines influence motor development by providing opportunities to practise, by strengthening muscles and stability, and by facilitating visual-motor learning.
Early childhood 	Fine motor skills Gross motor skills	*Body:* Longer arms and legs and greater muscle control contribute to smoother, more coordinated movement. *Brain:* Myelination leads to improved coordination of various regions of the brain, which is necessary for motor control. *Behaviour:* Constant activity contributes to skill and muscle development.	Provide opportunities for practising fine motor skills, such as manipulating pencils and scissors, zips, laces and buttons, and for use of gross motor skills, such as climbing, running, jumping, throwing and kicking balls.
Middle childhood 	Combining skills Refinement of gross and fine motor skills	*Body:* There are increases in strength, agility and balance with continued growth in height and muscle mass. *Brain:* Development of executive function contributes to coordination of motor movements. *Behaviour:* Activity levels remain high; organised games played at school contribute to coordination and movement problem solving; common school activities such as handwriting practise fine motor skills.	Encourage physical activity, including team games. Fundamental movement skills can be explicitly taught to improve children's enjoyment of and skill in games.
Adolescence 	Increased strength and coordination of both fine and gross motor skills	*Body:* There is increased height and muscle mass, particularly in boys. *Brain:* Further development of executive function contributes to coordination and control of behaviour. *Behaviour:* Individual differences in motor skill are strengthened by young people's choices about involvement in physical activity.	Encourage physical activity.

Sources: Adapted from Adolph and Berger (2010); Kopp (2011); McDevitt and Ormrod (2010).

Image sources: 1: © Petro Feketa/Shutterstock.com., 2: © Ternych/Shutterstock.com., 3: Christopher Futcher/Getty Images., 4: Dotshock/Shutterstock

VARIATIONS IN PHYSICAL DEVELOPMENT

Individual differences in the rate of physical development and the timing of major milestones such as puberty occur between males and females, and across different social and cultural groups (see Figure 2.6). These differences attest to the combination of environmental and inherited factors involved in development.

Source: wavebreakmedia/Shutterstock

FIGURE 2.6 The timing of puberty varies from individual to individual.

Environmental influences

Adolescent girls in industrial societies tend to experience menarche earlier than those living in countries with widespread poverty. As the onset of menarche is associated with increases in body fat, nutritional factors are likely to be responsible for this difference. Girls who participate in rigorous exercise programs – such as those for athletes in training – also tend to experience menarche later than their peers (Rees, 1993). In industrial societies, and in some developing nations, the age for menarche onset has declined steadily over the past century or more, probably as a result of improvements in nutrition and general health (Tanner, 1990).

Differences in growth rates and eventual height also have been observed among people from different countries (Evelyth & Tanner, 1990). There may be genetic factors involved in these differences, but it is likely they are also related to diet and to health issues such as the prevalence of disease in particular countries. People from countries with widespread poverty tend to be smaller on average than those from industrialised nations such as Australia and New Zealand, although there is also variation within populations. Indigenous Australians living in remote communities tend to have poorer health than the Australian population in general, with higher levels of infectious disease, poor sanitation and housing, malnourishment and limited access to clean water. A study comparing the growth of Aboriginal children in the Kimberley region of Western Australia with international norms showed the influence that environmental factors can have on infant growth, and that low birth weight was significantly related to later growth (Roberts, Gracey & Spargo, 1988). The pattern is similar to that of malnourished infants in the developing countries – thriving in the first three months and then faltering in height and weight (Burns & Irvine, 2004). Follow-up studies of these Aboriginal children showed that overall growth at 10 years was appropriate for those living in urban areas, but not for those in remote areas (Mackerras et al., 2003).

Other areas of physical development are also influenced by environmental factors. Some of these are associated with a child's development in the womb; for example, pregnant mothers' consumption of alcohol and tobacco (as well as less widely available drugs) is associated with abnormal physical and brain development (Berk, 2012). Other influences may be felt later in the child's life; for example, high levels of family conflict are associated with earlier onset of menarche (Manuck et al., 2011), while Whittle et al. (2014) reported from a longitudinal study that warm and supportive parenting influenced the development of adolescent brain structures that are associated with positive emotional and behavioural outcomes. Environment is a significant force throughout the course of development.

Development of children with physical disabilities

Some physical conditions, such as cerebral palsy, spina bifida, Down syndrome and muscular dystrophy, result in a different developmental path, and the acquisition of motor skills may be challenging for some students with specific physical disabilities. Nonetheless, you should not assume that a child with a physical disability also has an intellectual disability, nor that they do not need to develop their physical

or motor skills. Supporting students with physical disabilities to participate in the classroom may involve making adjustments to the way in which you teach, the physical environment, equipment and tasks. For example, a student in a wheelchair may be able to participate in a long-jump exercise by using their arms to propel the chair forward, a parallel task to the spring another child must make using their legs. Chapter 10 deals in detail with the inclusion of children with special needs.

Sex and gender differences

You have probably heard it said that girls mature faster than boys. Physically, this tends to be true, with girls reaching some milestones several weeks ahead of their male counterparts during infancy, and the gap widening through childhood so that girls may reach the end of puberty as much as two years ahead of boys (Tanner, 1990). Boys are generally taller and heavier than girls throughout childhood, with the exception of a brief time in early puberty (around 11 years old) when girls go through the pubertal growth spurt about two years ahead of boys.

Differences such as this, which have a strong biological basis, are generally referred to as sex differences. Other differences between boys and girls have a mixture of biological and social origins. The term 'gender difference' is generally used to refer to these kinds of differences. As it is often difficult to determine whether a difference we observe has a biological or social origin, in this book, we tend to use the term 'gender difference'. Chapter 11 discusses gender differences in more detail.

Gender differences in motor-skill development are increasingly evident from early childhood through to adolescence. In early-childhood tests of motor ability, girls perform better at locomotor skills and stability such as are used in balance tasks, while boys have better manipulative skills such as are used in hitting and ball skills (Iivonen & Saakslahti, 2014). This difference persists through childhood, with boys proving more proficient at object-control skills and girls at locomotor skills in grades 4 and 5 in one Australian study. This study also found that children proficient at object control were more likely to be involved in physical activity as adolescents (Barnett et al., 2009). This finding is consistent with trends reviewed by Iivonen and Saakslahti. Later, boys tend to be better at sports that involve force and power, while girls are more skilled in fine motor tasks and activities that require agility (Malina, 1998). These differences are partly a result of boys' greater muscle mass and heart and lung capacity, but can also be attributed to the societal roles apportioned to males and females. Boys tend to be encouraged to play ball sports, while girls are steered towards dance and gymnastics. While a five-year-old boy might be given a football or basketball as a gift, a girl is more likely to receive (and to ask for) a skipping rope. In addition, boys tend to be admired by peers for sporting prowess, something that tends to be far less important to girls and that is probably related to the relative significance placed by the media and society on men's versus women's sport. Similarly, boys are more likely than girls to play computer games (see Chapter 12).

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Online resources
Go further: See resources for developing children's fundamental movement skills at 'Get skilled get active'.

BOX 2.3 CLASSROOM LINKS

PHYSICAL DEVELOPMENT IN SCHOOLS

- The connections observed between physical development and developments in cognition and emotion suggest that opportunities for a range of physical activities should form part of schooling.
- Motor-skill development is an important part of the curriculum in preschool education in Australia and New Zealand, and health and physical education is a Learning Area in the Educational Goals for Young Australians (MCEETYA, 2008) and in the New Zealand Curriculum (New Zealand Ministry of Education, 2007).
- The New Zealand Curriculum (New Zealand Ministry of Education, 2007) adopts the Māori philosophy of health and wellbeing, or *Hauora*, which recognises the interconnection of

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taha tinana (physical wellbeing) with *taha hinengaro* (mental and emotional wellbeing), *taha whanao* (social wellbeing) and *taha wairua* (spiritual wellbeing).

- Physical exercise can contribute to academic learning through motivation as well as cognitive skills such as attention and memory.
- Children with physical disabilities may take a different developmental path, but they still require opportunities to participate in physical activity at school. Adjustments can be made to tasks, equipment and the environment to enable them to participate alongside their peers.

Gender differences in physical activity and exercise involvement are more widespread than this, however. The 2007 Australian National Children's Nutrition and Physical Activity Survey (Australian Government, 2008) found that girls spent less time than boys in vigorous physical activity, though this mainly related to the amount of time spent playing sport (see Figure 2.7). Given the links between physical activity and learning discussed earlier, as well as the demonstrated relationship between physical exercise and the risk of disease, these differences are of widespread concern, and schools have sought to address students' physical activity levels. Iivonen and Saakslahti (2014) and Barnett et al. (2009) – cited above – argued that developing girls' object-control skills in early and middle childhood is an important part of the solution.

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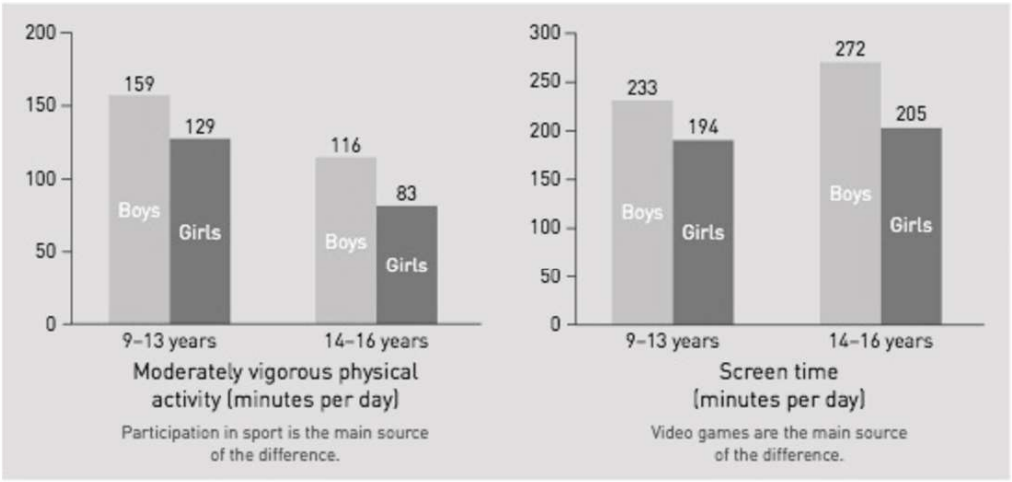
Online resources
Watch a **video** of an adolescent girl talking about why her friends go to the gym.



Source: Commonwealth of Australia (2008)

FIGURE 2.7 Comparing boys' and girls' physical activity and screen time.

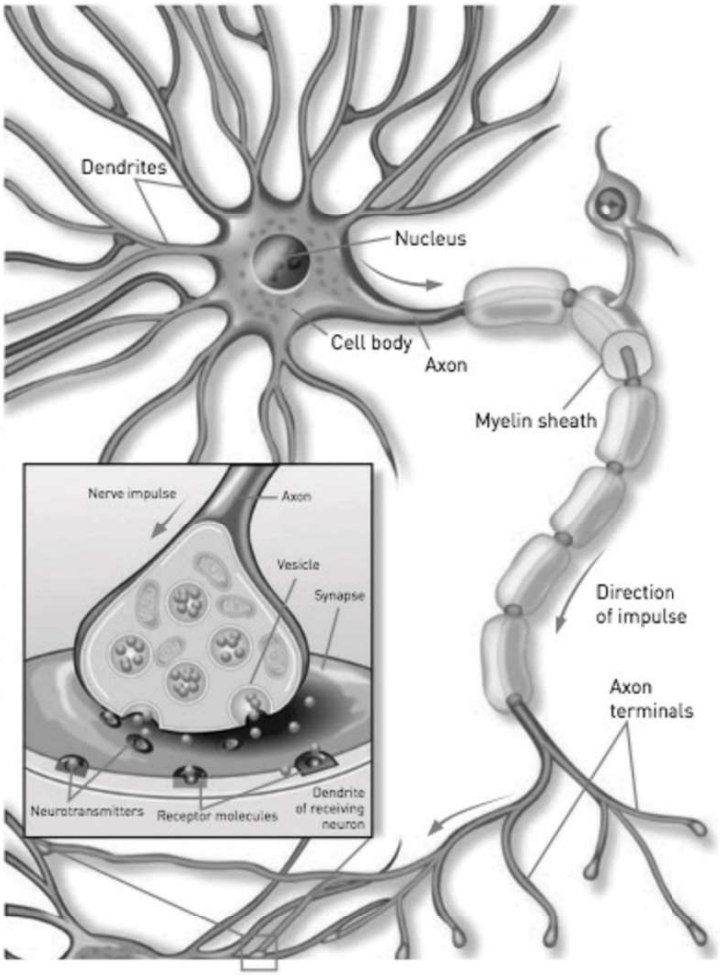
BRAIN DEVELOPMENT

One dimension of physical development that is particularly important in the learning and teaching processes is brain development. The brain directs the course of overall development and responds to environmental stimuli to promote its own growth. In this section we consider how the brain's physical structures develop, and how this development is related to visible changes in thinking and behaviour.

THE BRAIN'S PHYSICAL STRUCTURES

The development of the brain begins in the earliest stages of foetal life, soon after conception. **Neurons** or nerve cells develop and are responsible for storing and transmitting messages throughout the brain system. In the growing embryo, a process of neuron proliferation produces millions of neurons so that

neuron
A nerve cell



Source: Brain facts: A primer on the brain and nervous system, © 2008 Society for Neuroscience, www.sfn.org/brainfacts, p. 7

FIGURE 2.8 The neuron receives messages through its dendrites and passes messages along its axons and across the synapse to other cells.

at birth the baby's brain has most of the neurons it will need to grow and develop. It is estimated that the newborn baby has between 100 and 200 billion neurons.

Neurons transmit information to other neurons via a long arm-like projection known as an **axon**. When a neuron cell is activated or 'fired', information travels as an electrical impulse along the axon, and then crosses a gap called the **synapse** by means of a chemical **neurotransmitter**. The synapse thus forms a junction between neurons. The branch-like **dendrites** of the neighbouring neuron receive the message (see Figure 2.8).

Over the course of development, neurons develop in size and complexity, growing axon branches and dendrites that connect to other cells. This enables networks of cells to be connected as more synapses are formed. Many neurons are connected with thousands of other neurons, and organised in networks that interact with other networks. In addition, a process of **myelination** occurs, in which the axon is insulated in a fatty sheath that improves the speed of transmission by up to 100 times. This special insulating material enables information to be transmitted more efficiently across the neural networks.

The developing brain actually produces many more neurons and synapses than are eventually used or needed. Some neurons die off naturally, and unused or unnecessary synapses are pruned. By adulthood, the adult brain contains only about half the number of neurons generated during the developmental phase. It is believed that these natural processes enable the communication between the remaining cells to become faster and more efficient, and also allow room for new connections to develop.

axon
The long 'arm' of a neuron that carries messages to other cells by means of electrical impulses

synapse
The gap between the axon and dendrites of two neurons

neurotransmitter
A chemical substance that carries messages across the synapse between neurons

The process of the brain changing and adapting itself is known as **brain plasticity** and is a relatively new concept in neuroscience. It was once thought that the brain had little capacity for change and that 'hard wiring' occurred relatively early in life. Although there do appear to be 'optimal' periods of brain development, in early childhood for example, this does not mean that the brain loses its capacity for change throughout the lifespan.

There are several forms of brain plasticity that enable the brain to develop and recover certain functions. Developmental processes such as synapse pruning are one form of brain plasticity. The very nature of learning itself can also be considered as a form of plasticity when our neural networks alter to accommodate new information or skills. Changes in the body, such as a change in eyesight or a traumatic injury to the brain, may lead to another form of brain plasticity (Vanderbilt Kennedy Center, 2012). Examples of brain plasticity have been observed in adults who have experienced a major neurological

injury such as a stroke. Activation of the motor cortex after a stroke leads to remapping in the brain and some recovery of function in a paralysed limb, for example, or in the recovery of speech (Johansson, 2011; Schaechter, 2004).

dendrites
Branch-like protrusions from a neuron that receive messages from other cells

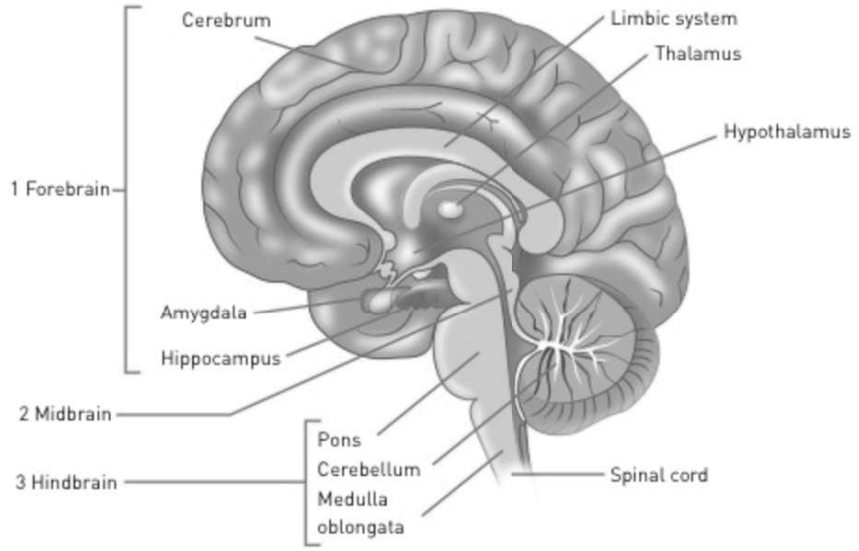
myelination
The process by which axons are insulated with a sheath of fatty cells, which improves the speed and efficiency of message transmission

brain plasticity
The capacity of the brain to change and develop new neural connections throughout the lifespan

INTERNAL STRUCTURES OF THE BRAIN

The brain is made up of both internal and external structures. It is generally the 'grey matter' of the external structures that we are most familiar with in images of the brain; however, the internal structures of the brain are just as important.

The internal structures of the brain are complex systems that control and activate some of the most basic functions of human life (see Figure 2.9). The hindbrain section, also known as the brain stem, contains structures such as the pons and the medulla, which control and regulate our breathing and heart rate; it also contains the cerebellum, which helps us control our movements as well as thinking processes that require careful timing and coordination. The centre of the brain also acts as a relay station to other parts of the brain. In the midbrain area are very small structures that take in sensory information (sight, hearing, smell, taste, touch) and relay this information to other parts of the brain. Higher in the central part of the brain is an area known as the limbic system, which is critical in the regulation and control of automatic drives and responses in the body, as well as emotional responses and memory. In this system, the hypothalamus helps relay information coming from the autonomic nervous system of the body, which helps regulate automatic and unconscious processes such as our sleep patterns, hunger, the activation of the pituitary gland and stress responses such as our classic 'flight or fight' response to stress. The hippocampus is believed to be very important in the memory of recent events we have experienced by helping us organise the 'what', 'where' and 'when' of these episodic memories (Society for Neuroscience, 2008). The amygdala is associated with emotional memories and learning, and is particularly associated with our fear responses. Many of these internal structures are linked and connected to the outer regions of the brain.



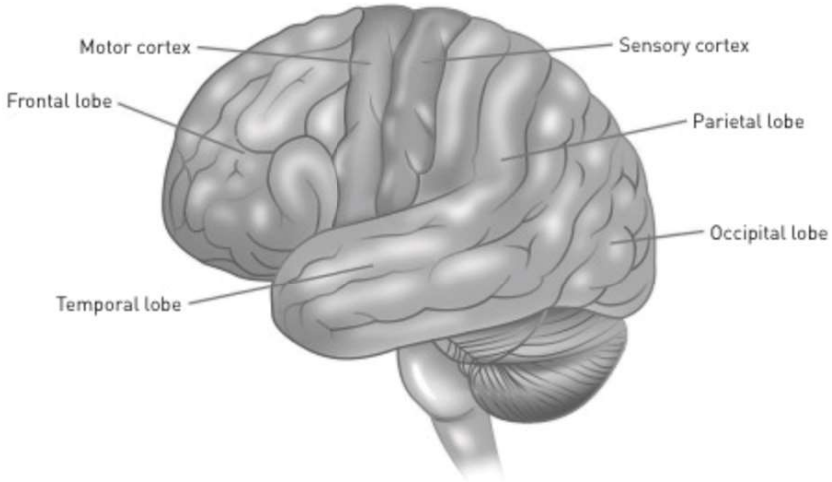
Source: *Brain facts: A primer on the brain and nervous system*, © 2008 Society for Neuroscience, www.sfn.org/brainfacts, p. 5

FIGURE 2.9 The internal brain structures.

The cerebral cortex

cerebral cortex
The outer layer of the brain, which is responsible for human intelligence

The **cerebral cortex** is the largest and last area of the brain to complete development and is considered the most important contributor to children's cognitive functioning (see Figure 2.10). The cerebral cortex is made up of two hemispheres that are linked by an internal brain structure known as the corpus callosum. In this way the inner structures of the brain can communicate with the outer structures of the cerebral cortex.



Source: *Brain facts: A primer on the brain and nervous system*; © 2008 Society for Neuroscience; www.sfn.org/brainfacts, p. 5

FIGURE 2.10 The cerebral cortex. Particular functions are localised in specific areas of the cortex; most skills involve the coordination of messages from a number of areas.

Different regions or lobes of the cerebral cortex are associated with specific bodily functions and abilities; for example, the motor cortex is associated with physical movement, and the visual cortex is associated with vision. One of the most important specialisations of the brain is known as **lateralisation**, in which the two hemispheres of the brain specialise in different functions. For example, the right side of the brain controls the left side of the body and the left side of the brain controls the right side of the body. The right hemisphere also processes visual–spatial information, non-speech-related sounds such as music, and recognition of faces and facial expressions. The left region of the brain is associated with the processing of spoken language and some logical thought processes. However, the lateralisation of the brain is strongly supported by *connectedness* between the parts of the brain. Not all processes function independently in one side or other of the brain; emotion, for example, is processed by the whole brain. The internal structures of the brain are critical for relaying emotional signals to the outer regions of the brain where, broadly speaking, the right side processes negative emotions and the left side positive emotions. Language is also processed in both hemispheres of the brain. It was once thought that all language abilities resided in the left brain, but it is now understood that recognition of spoken words and sounds occurs in both sides of the brain, and it is speech production that is strongly controlled in the left part of the brain. Damage in one of two critical areas in the left part of the brain, known as Broca's area and Wernicke's area, can produce specific deficits in speech output (Society for Neuroscience, 2008).

lateralisation
The specialisation of functions in the two hemispheres of the cerebral cortex

The degree to which our brains are specialised in these ways varies between individuals; for example, lateralisation is believed to be influenced by genetics or family similarities – it may be less strong in females than males, while left-handed people may also have less lateralisation than right-handed people.

Studies of the brains of mathematicians show use of centres from both sides of the brain when solving problems and doing simple arithmetic (Dehaene, Molko, Cohen & Wilson, 2004). In fact, most activities involve coordination of messages from both sides of the brain (see Box 2.4).

BOX 2.4 IMPLICATIONS FOR EDUCATORS

THINKING CRITICALLY ABOUT BRAIN RESEARCH AND THE CLASSROOM

Research into brain development has been prolific over the past two decades, but work investigating the application of this new understanding of how the brain works to classrooms is still in its infancy. Yet teachers around the world report that they are being bombarded by requests to join 'brain-based learning' workshops or attend seminars on 'brain-based teaching'. Although we are learning more about the structure of the brain, how this relates to its function in learning and teaching is still being examined and is very difficult to research. A number of research centres worldwide have taken up the challenge to investigate the applications of brain research to education.

Goswami (2004) reviewed links between neuroscience and education, and suggested some likely areas for useful application, such as in understanding reading acquisition and dyslexia, or in training children with autism to understand emotion. However, caution should be used when reading recommendations for teachers that are billed as being 'brain-based' (Fischer, 2004). Sometimes this label is used to describe educational applications that are based on educational psychology generally (for example, Caine & Caine, 1991), but others have claimed direct applications of neurological research to learning and teaching strategies that are not supported by research evidence. These are sometimes called 'neuromyths' (OECD, 2007). Here are some examples:

- Some educators have used brain lateralisation to explain children's academic strengths and weaknesses, describing students as being 'left-brained' or 'right-brained' (for example, McCarthy & McCarthy, 2005). Others have used this as a basis for programs that seek to tap into the skills of one or other side of the brain (for example, Edwards, 1981). Bruer (1999) warned against such simplistic applications of brain-lateralisation research, pointing out that most skills involve the coordination of messages from both sides of the brain. Healthy brains rely on the two hemispheres working together for most tasks.
- There are sometimes suggestions that males and females learn differently, based on differences in the structure of male and female brains. Fine (2010, 2013) drew on neuroscience research to show that there are in fact few reliable differences between male and female brains (differences within each group are larger than differences between them), and that those differences that do exist are not relevant to learning or education. Chapter 11 discusses gender differences in more detail.
- Because of the idea of 'critical periods' of brain growth and the concept of synapse proliferation, some programs targeted at teachers have suggested special teaching interventions that promote 'neuroplasticity'. In fact, any teaching intervention or life experience that leads to a change in behaviour and knowledge will be 'remapped' in the brain – neuroplasticity occurs naturally, without the need for costly programs.
- Knowledge of the importance of early experience to brain development has sometimes been taken up with 'enrichment' programs that claim to accelerate cognitive development by providing experiences early. Nagel (2013) spelled out a number of dangers in this approach, including the importance of the in-built developmental timetable of the brain, which supports learning at particular periods when the brain is 'ready' for them; this built-in timetable also ensures that cognitive and emotional development occur in tandem, and support one another.

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Online resources
Go further: Visit centres for research into the brain and learning via the link on this text's website.

- There may be sensitive periods during which the development of certain abilities is optimised, but these do not prevent learning from occurring later. For example, London taxi drivers who are particularly good at navigating around the city have been found to have enlarged hippocampi (the area responsible for spatial memory), suggesting they have developed synapses in this area in response to their task (Maguire et al., 2000, as cited in Goswami, 2004).

ACTIVITIES

What 'neuromyths' have you heard of in the classroom? Use the accompanying CourseMate Express link to make some online visits to centres for research in the application of neurological research to learning and teaching, and discover some of the evidence-based findings.

How are these processes reflected in the developments observed in children? As we discussed earlier in this chapter, one of the patterns of development is an increase in skill complexity and coordination that relates, in part, to the increase in networks of nerve pathways. In this section we will continue to explore developmental changes that occur in infancy, early childhood, middle childhood and adolescence. We also look at important factors that may influence brain development.

BRAIN DEVELOPMENT IN INFANCY

The infant brain experiences rapid growth and neuron proliferation. All experiences, especially sensory experiences, are important in the growth and development of the infant brain. As mentioned previously, in the first year of a child's life, the brain produces many more synapses than it will need; thus, the infant brain is readied for experience. Synapses that are not used – that is, do not receive stimulation – are pruned, while those that are used through environmental stimulation are strengthened.

One of the most well-known concepts in the development of the infant brain is the notion of an 'optimal period' or 'critical period' of development. From late in pregnancy to two years of age, brain development occurs at a great pace, and high-quality nutrients and an adequate 'energy supply' are important for the developing brain. However, it is the quality of the life experiences of the infant that are believed to be the foundation stones of a healthy future brain. As such, this critical period of development requires careful attention to factors that influence brain development and growth.

attachment
The strong emotional bond established between infant and caregiver

In this period of life, the warmth and security of relationships with primary care givers, known as the **attachment** relationship, is believed to be critical for the development of the social and emotional processing centres of the brain (Schore, 2001). Brain-imaging studies support the idea that brain development in infancy is greatly dependent on positive experiences and interactions with others, particularly primary caregivers. Brain imaging has been used to study the responses of mothers and infants when looking at each other's smiling faces. The brain images show that important social information-processing areas of the brain are activated when a very young infant sees an image of its mother's smile; similarly, the same region of the mother's brain is activated when she sees a smiling image of her child. In this way, critical neural networks are developed in the child's brain, and the attachment relationship between parent and child is strengthened.

The infant brain readily absorbs sensory information but is also active in sorting and understanding this information. This is especially clear in the area of understanding language. The newborn brain not only appears to recognise the native language but shows different brain activation in response to the familiar native language compared with an unfamiliar language (May, Byers-Heinlein, Gervain &

Werker, 2011). The infant brain shows discrimination of features of language such as melodic rhythm and stress, and babies as young as four months of age appear to show language-specific neural representations of word forms (Friederici, Friedrich & Christophe, 2007).

The quality of early life experiences is critical to healthy brain development in infancy and early childhood. As explained in the following sections, there is a significant difference between the brain development of an infant raised in a normal, caring environment and that of a child who has early experiences of abuse or neglect.

BRAIN DEVELOPMENT IN EARLY CHILDHOOD

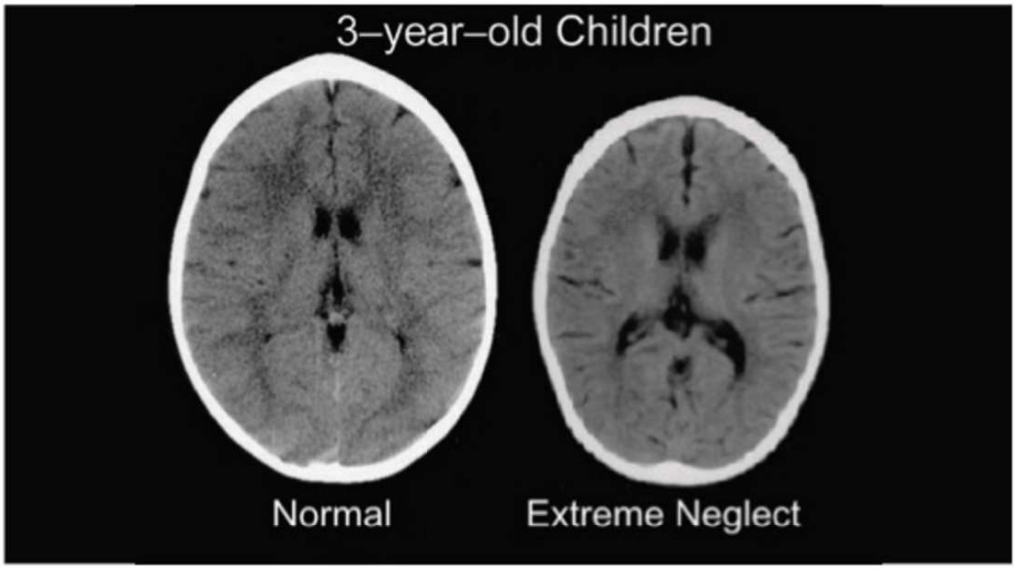
The period of early childhood sees rapid growth and development in areas of the brain that allow the child greater self-control. In particular, a growth spurt in the frontal region of the brain corresponds to the development of executive function skills, such as the ability to follow rules and directions and control impulses. (See more on executive function in Chapter 3.) For example, by three years of age most children can complete tasks that require them to follow two rules simultaneously, and by five years of age children can shift their attention from one rule to another to accommodate different situations. Young children can inhibit and control some impulses, allowing them to complete more complex tasks and follow instructions from caregivers, but they still need a lot of practice, positive experience and support from adults to reinforce these new skills in the brain (CDC, 2011).

This frontal area of the brain, the prefrontal cortex, also develops connections to other parts of the inner brain, including those structures that help us control our response to threat or stress (our 'flight or fight' systems). As such, the growth of executive functioning abilities requires a range of early-childhood experiences that allow executive skills to be tested within a caring and regulated environment.

A number of studies have shown that very dysfunctional (unregulated) and stressful early-life environments lead to a type of toxic stress that actually inhibits executive functioning. As an adult you might recognise such an effect when you have experienced the feeling of not being able to 'think straight' or remember critical actions when you have been faced with extreme stress or anxiety. In such situations the body releases chemicals, such as cortisol (also known as hydrocortisone), in response to the stress; these chemicals activate inner regions of the brain that send us into 'fight or flight' mode, inhibiting clear functioning of the prefrontal cortex. In the developing brain of the child, repeated and prolonged exposure to the chemicals released under stress seems to impair the neuronal 'architecture', leading to less-well-developed executive functioning systems. As an adult, you have the capacity to calm yourself or use your executive function to think of a response, but the young child's brain is still developing this ability (CDC, 2011, p. 7).

The brains of children who have suffered extreme neglect or abuse (physical, emotional or sexual) in early childhood appear to show stunted or reduced growth patterns (see Figure 2.11). The cerebral cortex and limbic areas of the brain appear to be significantly reduced in size (Perry & Pollard, 1997), and subsequent developmental problems in diverse areas of functioning have been noted (Kreppner et al., 2007).

Studies of Romanian orphans have shown that pervasive developmental problems persist for children whose neglect extends beyond the first six months of life. Due to brain plasticity, children whose circumstances improve within the first six months of life show greater brain recovery. The prolonged nature of neglect beyond six months of age seems to be related to psychological deprivation rather than nutritional deprivation. However, these studies have also shown the clear capacity of the human brain to improve and adapt beyond the early childhood years, enabling some improvement in cognitive function to occur into the middle childhood years for children with the greatest level of cognitive impairment at age six (Kreppner et al., 2007).



Source: Perry, B. D. (2002). Childhood experience and the expression of genetic potential: What childhood neglect tells us about nature and nurture. *Brain and Mind* 3: 79–100. www.childtrauma.org

FIGURE 2.11 These images illustrate the negative impact of neglect on the developing brain. The CT scans are from three year olds – one healthy, on the left, with an FOC (head circumference) in the 50th percentile, and on the right is a child who experienced total global neglect (including sensory deprivation). These images are from a series of 122 severely neglected children of many ages. In general the brains of the neglected children were significantly smaller and demonstrated various forms of abnormal development (e.g., cortical under-development and enlarged ventricles).

BRAIN DEVELOPMENT IN MIDDLE CHILDHOOD

The heavy focus in research and the media on the importance of brain development in early life has led to some concern that we may be neglecting or overlooking the fact that the brain continues to grow and develop throughout childhood and into adulthood (Cashmore, 2001). By the end of early childhood, the brain has reached 90 per cent of its adult size, and thus the main type of change seen in middle childhood relates to continued growth of the cerebral cortex, further synapse pruning, and myelination of more extended connections across regions of the brain.

In the middle years of childhood, executive function skills continue to improve as networks, and interconnections between parts of the brain grow stronger. These connections, visible as the 'white matter' in neuroimaging studies, show thicker neural connections starting to grow across and between different areas of the brain, hence connecting multiple areas of functioning together. The learning experience of middle childhood is about reinforcing and building upon these new connections. This is clearly visible in the classroom as children become much better at rule-based understanding, thinking about diverse topics and verbally expressing their ideas with greater confidence and clarity.

Although the amount of energy consumed by the brain seems to decline in middle childhood, indicating a slowing down of synapse proliferation, certain areas of the brain show continued energy consumption and activity. In particular, certain structures in the limbic system continue to grow, and these systems aid in the integration of emotional and bodily signals so that bodily awareness of pain or recognition of threats to the body is enhanced (Campbell, 2011). These areas of the limbic system are also implicated in the distress a child feels when experiencing social exclusion in middle childhood. This connection has been established in studies using a virtual game of 'Cyberball' along with brain imaging. During the game, other players deliberately bypass the child participant by throwing the ball to other players, leading to a feeling in the child of mild distress and rejection that can be measured in images of the brain. These studies have shown that the neural experience of the distress of rejection is very

similar to that of physical pain and sensation (Crowley, Wu, Molfese & Mayes, 2010). This provides vital evidence that an increase in bullying and social ostracism in the middle childhood years (for more detail, see Chapter 4) corresponds with the emerging capacity of the brain to understand and respond to this 'pain'.

Middle childhood is also the period in which many developmental differences in functioning between children are observed. Conditions such as attention deficit hyperactivity disorder (ADHD) and other learning problems associated with a lack of focus or ability to 'sit still' are observed by teachers. Some studies have linked the presence of ADHD with delays in the development of certain regions of the central cortex. Although the mechanisms of brain development or difference in ADHD are much debated, some researchers have found that slower maturation of the prefrontal cortex during middle childhood may explain some of the notable differences in executive functioning for children with this condition (Shaw et al., 2007), particularly impulse control, and maintenance and shifting of attention.

Brain development in middle childhood is the expression and refinement of many of the processes started in early childhood. Neural networks are faster and the regions of the cerebral cortex continue to grow, culminating in the final stages of growth in adolescence.

BRAIN DEVELOPMENT IN ADOLESCENCE

The adolescent brain enters a new 'critical period' of development during which two processes appear to underpin the emergence of the adult brain. First, as the grey matter of the cerebral cortex completes development, a process of synapse pruning begins, resulting in an adult brain that is actually *less* dense in grey matter than the childhood brain. This process of pruning is believed to make communication between different regions of the cerebral cortex extremely efficient. A second process also speeds up communication between different areas of the brain. An increase in myelination results in stronger and longer neural connections (or white matter) that extend to different parts of the brain.

One of the most interesting findings of the past decade relates to the final stages of growth of the cerebral cortex, and particularly to the finding that the prefrontal cortex is the final area of the brain to complete growth some time in the third decade of life, possibly as late as 25 years of age (Hickie & Whitwell, 2009). It is also known that male brains complete this final stage of development slightly later than female brains, probably due to the slightly later onset of puberty in males.

The continuing maturation of the adolescent brain has been linked to the slow and gradual emergence of frontal-lobe control of behaviour, and has been used as an explanation for impulsive and risky behaviour during adolescence (Romer, 2010). If you reflect upon the importance of the prefrontal cortex for executive functioning, as discussed in earlier sections, you will understand that the slow development of this part of the brain means that even adolescents still have limitations in their thinking and reasoning skills. Could the slow development of the prefrontal cortex make the adolescent particularly prone to impulsive or risky behaviours?

A number of researchers have adopted a 'brain-maturation' explanation of adolescent risk-taking behaviour. This explanation proposes that the 'risky' adolescent brain may be caused by different rates of development of two key areas of the brain. First, activation of certain areas of the brain known as the 'reward' circuits occurs relatively early in the adolescent brain. These circuits may encourage the adolescent towards novel and sensation-seeking activities. These activities may be of the kind that provide instant reward or gratification to the individual (for example, driving very fast or sexual activities). Second, the prefrontal cortex of the adolescent brain develops more slowly and is not yet mature enough to help the adolescent handle these risky situations (Romer, 2010). A more mature and adult-like prefrontal cortex is what enables us to step back and carefully assess a situation, engage in forward thinking, and plan or prepare for likely outcomes. Adolescents who engage in sensation-seeking or rewarding behaviours may often say to adults 'Oh, I didn't think of that!' when confronted with the

Source: © Angie Knost/Alamy

FIGURE 2.12 Some researchers attribute risk-taking behaviour in adolescence to the pattern of brain maturation. What other factors could contribute?

outcome of their behaviour. The brain-maturation perspective suggests that the adolescent is not just making an excuse but has a real problem in connecting sensational activities to risky outcomes.

However, it seems that the developing adolescent brain, or weakness in executive functioning, does not provide all of the explanation for difficult adolescent behaviour (Romer, 2010). For example, it is clear to teachers, parents and researchers that not all adolescents take risky pathways at this time of life. There may be other factors that explain why a relatively small group of adolescents engage in extremely problematic behaviours such as binge drinking or physically aggressive behaviours. In the previous sections we discussed the role of early-life experiences in shaping and setting up the foundations of a healthy future brain. Early-life exposure to toxic stress has been linked to several negative outcomes in adolescence, including suicide, drug use and development of addictions. Longitudinal studies show that for a small number of individuals, a pathway of impulsive or aggressive behaviours starts early in life and continues into adolescence or adulthood (for example, Campbell, Shaw & Gilliom, 2000; Nagin & Tremblay, 1999). This seems to suggest that the origins of some adolescent behaviours may be from much earlier in life, and may be associated with impulsive traits in certain individuals or the role of early-life experiences in shaping the future brain (Romer, 2010).

What should we conclude about the developing adolescent brain and its effect on behaviour? Certainly, there is wide agreement that adolescence is indeed a 'risky' time for some young people, but whether or not this is entirely due to a lack of cognitive sophistication is still uncertain. Romer (2010) suggests that some natural chemical processes in the brain that lead to sensation seeking are not necessarily associated with deficits in executive functioning or poor reasoning skills. Rather, the adolescent may simply need experience to help them cope with this new need for novel and sensational learning experiences. As with other stages of brain development we have studied, the role of experience and nurturing guidance is just as likely to be critical for the healthy maturation of the adolescent brain as it was for the early-childhood brain. Learning to take risks in 'safe' and regulated environments may be one such solution, and graduated licensing schemes are an example of experiential learning that has significantly reduced adolescent crash rates and injuries (Romer, 2010).

The continuing plasticity and growth of the brain into young adulthood also raises significant concerns about protecting the brain from harmful substances for as long as possible. Alcohol use during this final period of brain development is believed to affect parts of the brain that are still developing. Studies of the cognitive function of teenage drinkers show deficiencies in executive functions such as memory, attention, future planning and abstract reasoning (Hickie & Whitwell, 2009). Memory deficits in teenage drinkers are likely to be associated with a shrunken or underdeveloped hippocampus; the hippocampus is very important in the formation of memories. Executive functioning skills may be generally impaired because the prefrontal cortex region is also shrunken and reduced in size. Impulsive or risky patterns of longer-term behaviour may be established because of damage to these regions of the growing brain (Hickie & Whitwell, 2009). Further damage to the brain is likely to result when adolescents injure themselves as a result of drinking or other impulsive behaviours. Due to the 'critical period' of brain development, the adolescent brain is especially vulnerable to injuries that tend to result in much more severe damage to brain architecture and a lesser chance of a full recovery than might have occurred earlier in life (Hickie & Whitwell, 2009).

Despite these serious concerns about risky or impulsive behaviours during adolescence, it is important to remember that the adolescent brain is indeed developing and making significant advances that are very important for learning in the classroom and life in general. Executive function skills in shifting and maintaining attention improve. Memory skills improve, and the adolescent has a greater capacity to hold something in mind while they do another task or try to solve another part of the problem; for example, the adolescent who is learning to drive learns to be flexible in shifting attention from the primary task of driving to observing road signs. Social reasoning and perceiving emotional signals and cues also improves, leading to the deepening and greater intensity of adolescent friendships and other relationships (see more on social development in Chapter 4). It is also important to remember that many adolescents achieve incredible feats of deep intellectual thought (such as students who accelerate into university at young ages) and great displays of empathy and community awareness (such as adolescents who volunteer in their communities and abroad), and some show incredible self-control even while undertaking extremely risky pastimes.

THINK ABOUT

- What changes in behaviour would you see in the classroom from early childhood to adolescence as a result of brain development?
- What activities or supports could you offer as a teacher during each of the stages?

LANGUAGE DEVELOPMENT

Language expresses our intentions and desires, allows us to frame and express our thoughts, helps us to achieve our goals, and is fundamental to our relations with others. It is central to our cognition and social interaction, but its development is also influenced by cognitive, social and emotional development. Unlike physical development, language development does not occur without social interaction or the child's interaction with the environment. Language develops in context, and with a particular set of purposes.

LANGUAGE BUILDING BLOCKS

In describing the process of language acquisition, linguists have divided language into a series of five 'systems'.

Phonology refers to the sound systems of a language. The **semantics** of a language are the relationships between words and their meanings; for example, you know what the words 'cat' and 'dog' refer to because of your semantic knowledge. **Morphology** describes the way in which words are made up according to tense, gender, number and so on; for example, the difference between the forms write, writes, wrote and writing are aspects of morphology. **Syntax** refers to the grammatical systems that combine words into phrases and sentences. **Pragmatics** is concerned with the appropriate use of language in social settings; for example, 'Give me some cake now' is syntactically correct, but it is an impolite way to phrase a request in English. Knowing how to achieve your aims using language and how to express yourself appropriately are part of your pragmatic knowledge of language. Linguists tend to describe the five systems as separate, but of course they interact and work together to form the larger language system. As children learn language, they don't build it up system by system. Rather, as Tomasello (2006) argued, children acquire 'speech forms' or chunks of speech that have a particular purpose, and extract elements such as words from these larger chunks.

Children develop the key features of language in the first three to four years of life. Knowing the early processes of language development can help us understand later developments in literacy and second-language learning.

phonology
The sound system of language

semantics
The system of meanings associated with language

morphology
The combination of units of meaning in words; for example, listen + ed = past tense of 'listen'

syntax
The grammatical system that orders the construction of sentences

pragmatics
Rules for the appropriate use of language in social contexts

LANGUAGE DEVELOPMENT DURING INFANCY

In the first days after birth there are signs that language is developing. Infants' early cries use sound to communicate emotion, and infants discriminate between speech and other sounds, and between their mother's and others' voices (Sachs, 2001). They also learn the rules of taking turns in conversations in these first months, with 'visual conversations' observable in exchanges of eye contact between mothers and their babies. These early 'conversations' affect the rate of language development – a clue that social interaction is an important influence in language acquisition – and are complemented by verbal turn-taking conversations at about three months. Games such as peekaboo also contribute.

The sounds made by infants progress from cooing (mainly vowels) at about two months, to babbling (strings of consonants and vowels such as 'dadadada') about two months later. By about seven months, the babbling starts to sound more like language, and by the end of the first year, when the first words appear, they have the intonation and other sound patterns of the child's native tongue.

Gestures are the other pre-linguistic element that emerges at about the end of the first year, accompanying the emergence of language and significantly contributing to language development. A number of studies have linked young children's use of gestures to growth of vocabulary and the shift to two-word utterances (for example, Blake, Vitale, Osborne & Olshansky, 2005; Özcaliskan & Goldin-Meadow, 2005).

The use of gesture reflects the fact that children comprehend language long before they produce it, and this priority of comprehension over production continues throughout the course of language acquisition. The production of language forms appears closely linked to developments in cognition.

The first words tend to be limited in number, simple in pronunciation, and refer to familiar, concrete objects or important people – 'mum', 'dog', 'juice'. These words are used like phrases. In English, first words tend to be nouns, with verbs appearing later as they are more difficult to make sense of. The first verbs tend to refer to simple, frequent actions. Other languages show a different order of acquisition (Levey, 2014). Tomasello (2006) identified the typical purposes of 'holophrases' (words used like phrases) across many languages. Just as in infants' pre-linguistic gestures or utterances, they are generally statements or requests, asking for or describing a person or thing; more of something ('more', 'again'); movement of objects ('up', 'in', 'open'); actions of people ('eat', 'kick'); and comments on the locations of objects and people ('here', 'outside'). Added to these are simple questions ('What's that?') and social formulae ('thank you', 'bye bye').

telegraphic speech
Communication using two-word sentences, leaving out smaller words

Towards the end of the second year, the child's vocabulary increases rapidly to about 50 words, and words start to be combined to produce **telegraphic speech** of two words – usually to ask for more ('more milk'), to say no ('no bath') or to notice the presence or absence of something ('all gone'). With time, the range of meanings expressed broadens, although children in the two-word stage are still constrained to talking about the here and now. Aspects such as tense, gender and number appear as the length of children's utterances grows.

There are links in this early development to cognitive and emotional development. The spurt in vocabulary that occurs at the end of the second year has been associated with a number of changes in the nature of children's thought (Bloom, 1998). We have already noted that children first learn words referring to people or objects that are important to them. Infants' early words are also usually related to their actions: they first learn

Source: Westend61/Getty Images

FIGURE 2.13 Infants' gestures contribute to their language development and extend their communicative competence at this early stage of development.

the names of objects that move ('car', 'ball') and words relating to actions themselves ('up', 'gone', 'more'). With the development of object permanence (see Chapter 3) terms such as 'all gone' appear, and with early understanding of causality terms such as 'oh dear' and 'uh oh' are heard. One explanation of the link between cognition and this aspect of language is that children's vocabulary is acquired around the particular cognitive problems they are solving (Gopnick & Meltzoff, 1997). Tomasello (2011) argues that children use their cognitive and social-cognitive abilities to acquire language. Language also contributes to cognitive development; words help with concept formation (Lupyan & Thompson-Schill, 2012) and cognitive flexibility (McWhinney, 2010).

LANGUAGE DEVELOPMENT DURING EARLY CHILDHOOD

Between two and three years of age, children start to speak in three-word sentences, and with the word order of their native language (in English, subject–verb–object) (Maratsos, 1998). Grammar also develops, with categories such as nouns, pronouns and verbs appearing in sentences as adults would use them. Thus, preschoolers' speech begins to more closely resemble that of adults.

The kinds of errors children make as they acquire language reveal the process of problem solving in which they are engaged. Very young children 'underextend' and 'overextend' meanings of words as they work to define the limits of a category; that is, they may use the word 'dog' to refer to all animals (an example of **overextension**) or to refer only to their own dog (an example of **underextension**). They may also develop their own expressions for words they do not know by combining words. For example, Jake, who is four years and seven months old, said:

overextension
Inappropriate use of a word for a class of things rather than for one particular thing

underextension
Inappropriate use of a word for one thing rather than for a class of things

> You can't touch his head because there's a hole and you might hurt his thinking thing.

while Eloise, who is two years and four months old, said:

> Don't fall me down [drop me].

Over-regularisation of grammatical forms occurs at the preschool stage as children recognise a particular rule and attempt to apply it. Initially, they tend to ignore irregular forms and apply the rule universally; for example:

over-regularisation
Application of a grammatical rule, ignoring its exceptions

> I goed to the zoo with Nana and we seed a baby giraffe.

and

> He did it well-ly, Mummy.

It is a measure of children's understanding of the language system that such over-regularisations are limited to the appropriate part of speech (verbs, in 'I goed … we seed') and tense (the past, in this case). Some of these kinds of errors are also made by learners in the process of acquiring a second language, and by children learning to spell.

The emergence of grammar has been linked to children's ability to find patterns and form categories (Tomasello, 2005, 2011). As children begin to form more complex sentences by joining phrases together, another sequence is evident that appears to parallel cognitive development. The first joining word is 'and', followed by 'then' or 'when' and 'because' or 'so'. Children learn in a similar way about concepts: first that things can be grouped together ('and'), then that they can be sequenced ('then'), and finally that relationships may be causal ('because') (Bloom, 1998). Bloom reminds us that the same sequence is seen in children's storytelling and understanding of stories.

CourseMateExpress
Online resources
Explore an example of children's storytelling with the **Interactive Activity** on this text's website.

The pragmatics of children's language also develop throughout the periods of infancy and early childhood, as children's use of language moves from simple expressions of emotion to a realisation that language can be used to direct and control others. Children as young as two years old adjust what they

say to take account of the listener (Dunn & Kendrick, 1982), although they do this imperfectly until their awareness of others' points of view (perspective-taking ability) improves.

LANGUAGE DEVELOPMENT DURING MIDDLE CHILDHOOD

Although most of children's language development is complete by the time they enter school, there are some further developments in middle childhood. There is a greater use and understanding of abstract words and constructions through middle childhood and adolescence, and children's use of correct grammar improves as a result (McDevitt & Ormrod, 2013). Children's vocabulary increases from 50 words at 18 months old, to about 10 000 words in the first year of school, to 20 000 words by Year 3, and to 40 000 words as the child enters adolescence (Anglin, 1993). Reading contributes to this increase in vocabulary, as do direct instruction and increased opportunities to converse with adults about a range of topics, as happens at school. A more complex grammar develops in order to deal with the increasing number of words used, and there is a close relationship between vocabulary size and grammatical complexity (Bates & Goodman, 1999).

metalinguistic awareness
Awareness of and understandings about language

These changes are accompanied by a greater awareness of language itself, which we refer to as **metalinguistic awareness**. Children's awareness progresses from appropriate use of phonology, morphology, syntax, semantics and pragmatics to specific knowledge of the rules being followed and the ability to express these rules. Such awareness is particularly important as children learn literacy skills. It may be that the school context itself focuses children's attention on the nature of language (Gombert, 1992). Bloom (1998) suggested that children's language develops around and in response to the meanings and intentions of the child's activity. In the early years, the first words tend to refer to the important people, events and objects in the child's world. Then, as the child's context changes from home to school, the activities on which the child focuses attention also change. Quite a bit of time is spent in classrooms talking with children about what language does and how it works. The meanings talked about are often to do with language itself, which helps children to develop their cognitive understanding of language.

Children's language play reveals a developing metalinguistic awareness. Early play with language tends to focus on phonological (sound-related) features. For example, this is from Harry (four years old):

> Hello Jacob Wacob.
>
> Jacob wacob cacob macob.

This kind of play with the sounds of language contributes to later developments in reading. It can be supported with nursery rhymes and stories that make use of repetition and rhyme (Bryant, Bradley, McClean & Crossland, 1989).

As children become more aware of other features of language, they move from being concerned with purely phonological features to an interest in playing with semantics and syntax. For example, Jack (aged six) said of his baby brother:

> Harry will be good at basketball when he grows up, because he dribbles a lot.

Jacob (aged five) said this when he learnt his cousin's name:

> I'm not going to call him Henry. I'm going to call him Chickenry.

This shift is displayed through an interest in riddles when children are about six to eight years old. Once again, there is a link between the ability to understand riddles and reading ability (Ely & McCabe,

1994). The metalinguistic skills involved in interpreting riddles are the same as those involved in making sense of a text.

In late middle childhood and adolescence, with increasing awareness of the rules for language use, children can become pedantic about what is said and how (and delight in picking up their teachers or parents on errors!); for example:

> 'Can you take the garbage out?'
>
> 'Yes I can … Oh, do you want me to? I thought you were just asking if I was strong enough. Ha, ha!'

LANGUAGE DEVELOPMENT DURING ADOLESCENCE

Adolescents have greater opportunities to acquire specific language forms and practices through participation in contexts outside home and school (for example, in workplaces or interest groups), and may shape their language to fit a variety of contexts (Smith Gabig, 2014). In addition, they spend considerable time in school navigating the academic language used in classrooms, with its particular rules.

By the final year of schooling, adolescents may have a vocabulary of up to 50 000 words (Stahl & Nagy, 2006). Increases in vocabulary during adolescence include the wider use of a variety of forms such as connectives ('although', 'however', 'nonetheless') and more complex words using prefixes and suffixes (for example, 'hope' may be expanded through the use of 'hopefulness', 'hopeless' or 'unhopeful'). There are also further developments in syntax, with mastery of complex forms such as passive ('It was taken by him' rather than 'He took it') and nested clauses ('The man who was riding the elephant's camera'), and use of more cohesive devices such as pronouns and conjunctions (Smith Gabig, 2014). Wider reading and exposure to subject-specific texts contribute both to vocabulary and to syntax development. Correct use of subtle distinctions in word use – as in the use of 'can' and 'want' in the garbage example given above – are probably learnt through formal instruction (Smith Gabig, 2014).

Development of abstract thinking in adolescence is reflected in language. The ability to compare what is said with the underlying reality allows adolescents to go beyond the literal. This ability shows itself in increased use and understanding of figurative speech, sarcasm and multiple meanings (McDevitt & Ormrod, 2013). Such developments are also related to further increases in metalinguistic awareness, with some students enjoying debating, arguing for the sake of arguing, and using language to think through ideas.

Nippold (2009) argued that more complex thinking, as well as the need to give information through exposition, prompts the use of more complex language in middle childhood and adolescence to communicate the new ideas and information students are thinking about. This parallels the link described earlier between younger children's language development and their cognition.

ADULTS' ROLE IN LANGUAGE ACQUISITION

Joint attention

When parents and children both focus on an object or activity in **joint attention** sessions, language learning is more rapid when parents do not interrupt or change the focus but instead talk about the object of the child's attention (Carpenter, Nagell & Tomasello, 1998). In these interactions, adults are supporting children's language development by labelling their environment for them. Tomasello (2005) suggested that children's ability to follow and direct attention underpins language development, as the purpose of language lies in responding to and manipulating others' thinking.

joint attention
When carer and child together attend to a stimulus, such as when reading books or playing peekaboo games

Rogoff (1990) showed that children play an important, active role in such situations, directing much of their interaction with adults and initiating conversations or joint attention sessions. By being in charge, children can direct the focus to an issue of concern to them, keeping learning at an appropriate level. Implicit in this is the assumption that children attend to their environment selectively, learning from the experiences they are interested in and can make sense of.

THINK ABOUT

- How might we let individual children control the focus and pace of their learning in the school context?

Child-directed speech

Adults worldwide adjust their language when talking to children, producing a special register of speech termed 'motherese' or **child-directed speech**. This type of speech tends to be higher in pitch than other speech, simple in grammar and vocabulary, and characterised by exaggerated expression and enunciation of words. It appears to help children separate the flow of speech into words, and to attend to the key words in a communication (Snow, 1995). Even children adjust their speech in this way when talking to babies. Infants show a preference for child-directed speech compared with other adult talk (Cooper & Aslin, 1994), and its use in the first year is positively related to infants' language comprehension at 18 months (Murray, Johnson & Peters, 1990).

child-directed speech
A type of speech directed to young children and characterised by high pitch, short and well-spaced sentences, simple vocabulary and exaggerated intonation

The content of child-directed speech is also important in children's language development. Cameron-Faulkner, Lieven and Tomasello (2003) found that there was a limited number of phrases with which mothers in their study initiated utterances to their two- and three-year-old children. In fact, there were 17 phrases that initiated 45 per cent of utterances. They included units such as 'what', 'that', 'it' and 'you'. The children used the same initiating phrases in their own speech. The researchers concluded that the often-repeated phrases help the children to reduce the variety of the great number of utterances they hear (5000–7000 per day) and seek to comprehend and to use themselves.

Adults' speech and gestures directed to infants help them to make connections between words and their meanings (Zammit & Schafer, 2011). Children influence the words they hear as mothers interact with them around objects they show an interest in. Mothers also tailor their language to children's ability level (Ucelli & Pan, 2013).

Expansion and recasting

As well as simplifying what they say, parents may amplify what the child says, repeating the child's statement with an **expansion**, and **recasting** errors in grammar. For example, the child's phrase 'Daddy work' may be responded to with 'Yes, Daddy's gone to work in his car, hasn't he?', expanding the information by adding 'in his car', and recasting the phrase into correct grammar: 'Daddy's gone to work'. Children repeat adults' recasts, but the contribution that expansions and recasts make to children's language acquisition is a matter of debate (Nicholas, Lightbown & Spada, 2001).

expansion
Parents' tendency to respond to young children's utterances by restating them in a more elaborate form

recasting
Parents' tendency to respond to children's utterances by restating them in the correct grammatical form

Language input

As we have seen, direct instruction at school and the language of school contribute to growth in children's vocabulary, use of correct forms, and their metalinguistic awareness. It has been estimated that children are exposed to an average of 3000 new words in every school year (Smith Gabig, 2014). This contributes not just to vocabulary but also to knowledge of morphology – how words are put together – that in its turn contributes to further language skills.

It is also clear that the amount of language in the home affects the rate at which children acquire vocabulary. This is one explanation for differences in language detected between people of various social classes. In a landmark study, Hart and Risley (1995) found significant differences in the amount of language directed at children in different socioeconomic groups. Particularly affected were children of families in situations of poverty: these children had a third of the interaction and experience with language of children in families from higher socioeconomic strata. The acquisition rate also links to later achievements. In the same study, Hart and Risley found a positive correlation between children's language experience before three years of age, and verbal intelligence scores at ages nine to 10. Socioeconomic status is not the only factor at work here. Pan, Rowe, Singer and Snow (2005) found variation within low-income families, with observed variation in the growth of young children's vocabularies positively linked to maternal language and literacy skills, and negatively linked to maternal depression. In Chapter 11 we explore the contribution of socioeconomic factors to individual differences in more depth, including the variability observed within and among different social and ethnic groups.

Later studies have suggested that children also learn from overheard speech, particularly when they are being talked about, or when others are talking about something they are interested in (Floor & Akhtar, 2006). A recent study found that in naturalistic settings, overheard speech from multiple others in the household (such as siblings, aunts, uncles or grandparents) did not contribute to children's vocabulary, although the researchers pointed out that it is likely that overheard speech contributes to other aspects of language, and/or that in other cultures it may play a greater role (Shneidman, Arroyo, Levine & Goldin-Meadow, 2013).

Bryant (2013) identified a number of strategies parents use to 'socialise' language in their children, contributing to their communicative competence. These include prompts, modelling, reinforcement, evaluation and other forms of input. Activities engaged in at home that prompt language also play a role. Rodriguez et al. (2009) found that three-year-old children's vocabulary was predicted by a combination of the frequency of their participation in literacy activities, the quality of the mother's engagement, and the availability of age-appropriate learning materials in the home.

THINK ABOUT

- How could you contribute to children's language development at school?

THE ROLE OF PEERS AND THE CHILD THEMSELVES IN LANGUAGE ACQUISITION

Language play

Throughout this chapter, we've seen a number of ways in which children's activity contributes to their development. Play is a particular kind of activity that is especially important to language learning. Children's play with language contributes to their metalinguistic awareness, as they play with sounds or with meanings.

In fantasy play, children negotiate meaning with one another, and must experiment and revise what they say in order to clearly communicate their ideas for the imaginary situation (Smith Gabig, 2014). Vygotsky (1977) described play as a supportive context for the development of children's thinking; for more on Vygotsky's view of the role of play in cognitive development, see page 108. It also clearly supports their language development.

Peer interaction

The importance of friendship and peer relations to children makes this a motivating context in which language is shaped to achieve acceptance and maintain friendships. In peer interactions, children develop and practise language skills in coordinating play, resolving conflict, and negotiating with and persuading

Source: Gladskikh Tatiana/Shutterstock

FIGURE 2.14 Children's interaction with peers during play contributes to their language development, with new requirements for using particular forms, opportunities to practise, and motivation for communicating effectively.

others (Smith Gabig, 2014). The role of peers in second-language acquisition (discussed later in this chapter) is also important (Philp, Adams & Ishawita, 2013). For example, children acquire and practise new language forms in the context of interactions with peers, and may adopt the language forms of their peers to appear more like them (Philp & Duchesne, 2008). Language both contributes to and is influenced by the social development of the child. We explore social development in greater detail in Chapter 4.

INDIVIDUAL DIFFERENCES IN PATHWAYS TO DEVELOPMENT

As we have seen, children's communication skills are developed through interactions with multiple others: parents, siblings, teachers, peers and others, each of these working differently to provide different kinds of interaction, feedback and input, depending on who is being conversed with, and in what context. Opportunities for language learning vary for different children, and for different families (Goldfield, Snow & Willenberg, 2013). The child's own interest and motivation play a role as well, influencing what they attend to (Bryant, 2013), with the result that there are individual differences in pathways to language development as well as in the language that develops.

In the section that follows, we discuss how children's prior experiences in language and other areas contribute to their understanding and to their learning in school. Being aware of the interests and activities for which children use language, including playing with language itself, can help us as teachers to make learning relevant for students.

BOX 2.5 IMPLICATIONS FOR EDUCATORS

LANGUAGE DEVELOPMENT AND THE CLASSROOM

Some of the principles drawn from how children learn language suggest initiatives teachers can implement in classrooms to contribute to language development:

- Interaction contributes to language development: give students opportunities to interact with a wide range of partners on a range of topics.
- Develop vocabulary through talking with students and encouraging reading about a variety of topics.
- Allow children to direct the focus of interaction.
- Explicitly teach students how to use irregular forms. They may not hear them used consistently in everyday speech.
- Build students' awareness of language by talking about how language works, and by drawing attention to specific language features in relation to content areas.
- Contribute to metalinguistic awareness with the use of riddles, rhymes, jokes and metaphors in middle childhood – but ensure that all students understand them. Remember that there are individual differences in the rate of development.
- Similarly, explore proverbs and multiple meanings in adolescence, allowing students both to find layers of meaning in texts and to construct their own.

You will see more examples of ways in which language contributes to learning in the section on the school-based skills of literacy and numeracy below.

SCHOOL-BASED SKILLS

Children do not arrive at school without knowledge or skills. Physical and language skills developed in infancy and early childhood form an important basis for the skills that are the focus of schooling. In this section, we discuss three sets of skills that are central to the work of schools: second-language learning – for many children an essential skill necessary to access education – and the skills of literacy and numeracy. In each case, children's knowledge develops from very early in life and is built upon by formal teaching in schools. Each of these skills, too, is needed for learning across the curriculum throughout schooling and, indeed, life.

SECOND-LANGUAGE ACQUISITION

We described the process of first-language acquisition earlier, but for many children in Australia and New Zealand, English is not their first but their second (or maybe even third or fourth) language. Some children grow up with several languages. Others must acquire a second language when their families migrate to a new country, or when they start school if their families do not speak Standard Australian English. The term 'learners of EAL/D' (English as an additional language or dialect) has replaced the older ESL (English as a second language) term, recognising the range of language backgrounds these learners of English may have. For these children, acquiring a second language is an essential skill for success at school. Snow and Kang (2006) have drawn several conclusions from research on children's learning of a second language, in this context:

- Acquiring a second language in childhood can be intimidating and difficult, lead to temporary emotional problems, and take several years.
- The first language is at some risk of loss or decline under the influence of the second language.
- A child's continued development of the first language is more likely if the parents are bilingual and/or highly educated in the first language.
- Higher status languages and languages associated with schooling and literacy are in general less subject to attrition than lower status languages.
- First language literacy skills can be a support to second-language acquisition.
- Learning to read a second language is easier if one is already literate in a first language.
- Literacy skills contribute to higher levels of oral proficiency in both a first and a second language.
- Older children typically learn a second language faster than younger children, perhaps because of their better developed literacy skills.
- Transfer of literacy skills can support second language literacy but may not occur automatically across even closely related languages.

Source: Snow and Kang (2006), pp. 78–9.

BOX 2.6 CLASSROOM LINKS

STAGES OF SECOND-LANGUAGE ACQUISITION IN THE CLASSROOM

What will you see in the classroom? There will be considerable variation in learners' progress in English as an additional language or dialect, depending on their age, experience and context, but five broad stages of development have been identified. Goldstein (2014) summarised the features of these stages of second-language acquisition.

Stage 1: Preproduction

As in first-language acquisition, learners' receptive language advances further than their expressive language in the early stages of language learning. There may be a silent period of up to six months during this stage, and/or a period when students converse with peers but not with adults in the new language. This should be seen as a natural aspect of the early stage of second-language acquisition. Students respond to simple commands and can understand up to 500 words.

Stage 2: Early production

The focus on receptive language continues. Approximately 3–6 months after being introduced to the new language, students understand yes/no and what/when/why questions, and generally use one- to three-word phrases and formulaic expressions such as 'How-are-you?'. They understand and use up to 1000 words.

Stage 3: Speech emergence

Six months to two years after being introduced to the language, learners' comprehension improves, and their vocabulary expands to allow them to talk in simple sentences. Some grammatical errors are shown in their speech and writing as they start to use more complex grammar. Vocabulary increases to about 3000 words.

Stage 4: Intermediate fluency

Approximately three years on, comprehension improves still further, and learners show competent skills in face-to-face conversations. They can express their thoughts and opinions using complex constructions, and show few grammatical errors. Vocabulary continues to increase, to approximately 6000 words.

Stage 5: Advanced language proficiency

Five to seven years after being introduced to the language, students' grammar and vocabulary are similar to those of a native speaker. They can use the specialised vocabulary of particular subject areas and can participate in classroom activities at their grade level.

ACTIVITIES

1 Identify the supports that learners would need in the mainstream classroom at each of the stages. See also Box 2.7 for further ideas relating to particular age groups.
2 One of the first things students learn is to ask to go to the toilet. Consider other practical needs, and particular language that students may need to participate in your subject area.

Comparing first- and second-language acquisition

There are some similarities between the ways in which first- and second-language learners use language, which seem to be related to the nature of the language-learning process. There are also important differences arising from the contexts in which people learn first and second languages. The focus in this discussion is on learning EAL/D, something that confronts non-English-speaking migrants in Australia and New Zealand and some Indigenous children in Australia. Foreign-language learning (for example, speakers of Standard Australian or New Zealand English who learn French or Vietnamese in classrooms in Australia or New Zealand) is a different although related process.

Similarities between first- and second-language acquisition include an early dependence on routine phrases such as those in telegraphic speech. Young children may use phrases such as 'all gone' for all situations where an absence of something is indicated, later recognising that these phrases can be combined with other language units to make phrases such as 'all gone milk', or separated to make phrases such as 'Mummy gone'. Second-language learners at early stages similarly depend on remembered language chunks – formulaic phrases that have not been separated into their component parts, and that cannot therefore be applied flexibly or adapted and expanded upon. Such use of formulaic phrases is an important support in the learning of a second language. Some common examples are the questions 'Where is it post office?', 'How are you your father?' and 'Who is she this man?'. The constraint at this early stage may be one of memory, since when confronted with a large, unfamiliar system, people commonly start with a small sample of language and build from there. The overgeneralisation of grammatical rules is another feature of both first- and second-language acquisition. The problem-solving nature of the language-development task is evident here.

There are some important differences between learning a first and a second language, however (remembering that we are not discussing bilingualism at this point, but the learning of a second language at school). In particular, while the learning of a first language can be assumed for the majority of children, such assumptions cannot be made about the learning of a second language. Children learning a second language bring with them understandings about language and the way it operates that can both assist and hinder them in their learning of the new language. Nicholas and Lightbown (2008) point out that learning a second language is a different process that has implications for teachers in their support of second-language learners alongside native-language learners in the classroom (see Box 2.7). They also caution that the age of the child makes a difference: under seven years of age, there appears to be a different process than for children over seven, due in part to the rapid development of understandings about language that are occurring at this earlier stage, apparently without instruction, and in part to the importance of literacy from the age of seven onwards.

BOX 2.7 IMPLICATIONS FOR EDUCATORS

Nicholas and Lightbown (2008) pointed out that the process of learning a second language differs for children of different ages. Following are some suggestions from the literature for supporting second-language learners in early childhood, middle childhood and adolescence.

EARLY CHILDHOOD

- Young children (under seven) draw on features of their first language, such as word order, to help them to meet the challenges of producing second language.
- There may be extended periods (months, or even a year such as in one case) of silence during which students understand but do not produce the second language. This may be strategic, with children focusing on learning from input before they attempt to produce it.
- Children may 'code-switch' – use a mixture of first and second language – and need to learn when this is appropriate, and when they might not be understood.
- Language play is an important feature of young children's use of first language (see page 48), and through it, second-language learners can learn and explore the features of the new language. For example, teachers can use language play to explore difficult features such as pronunciation through tongue twisters and rhymes. Children can also attain an identity as a peer in the classroom through language play and mimicry (Philp & Duchesne, 2008). Lightbown and Spada (2008) point out that it is important, however, for children to move on to adult forms.
- For young children, the focus should be on language associated with activities, actions and simple thinking operations, with language presented and used in context.

>>

MIDDLE CHILDHOOD

- Children need not only to learn the second language, but to learn through it as well, so that they can develop skills in using the language for academic purposes.
- Second language can be taught in the context of, and through, all curriculum areas, not just in English classes.

ADOLESCENCE

- Older children may learn from decontextualised language, and from language associated with more complex thinking.
- Students apply their knowledge of their first language and may rely on translating to a greater degree than younger learners. They need also to develop knowledge of the second language and how it works, so that they can draw on this knowledge independently of the first.
- Identity can be particularly important for students in adolescence, and language is part of identity. Consider how to support second-language learners to construct identities as full members of the class group.
- Opportunities to interact informally with native speakers are important both to provide input and to allow the practice of output. Encouraging positive relationships between native and non-native peers in the classroom can thus be valuable.

Sources: Nicholas and Lightbown (2008); Ellis (2005); Gibbons (2002); Muñoz (2007).

Why is it that learning our first language sometimes seems effortless and automatic, while learning a second language can be a long and difficult process? The contextual features of second-language acquisition make it a more difficult task than learning a first language. In first-language acquisition, children tend to be supported by their parents, with intense one-to-one interaction focused on the child's level and the activities the child is engaged in. Second-language acquisition rarely occurs with this level of intense support. In addition, as we have seen, the child's emotional, social and cognitive development is progressing in tandem with language development, supporting and being supported by it. When second-language acquisition happens later, this match does not occur, and the child has often quite complex thoughts, ideas and emotions to express in the new language. There are emotional and motivational differences, too. As we saw earlier, first-language acquisition is an intrinsically motivating task for the child due to caregivers being involved in the process. There are many rewards for success – and even for failure – when parents respond to the child's requests and attend closely to clarify meaning. Second-language learning can be frustrating and anxiety-producing, particularly for a newly arrived non-English speaker in an Australian or New Zealand school. When second-language acquisition occurs in the school context, there is also the double demand of learning about other curriculum areas through the second language (Nicholas & Lightbown, 2008).

THINK ABOUT

- How might the school context be shaped to support second-language acquisition?

Bilingualism and learning English as an additional language or dialect in schools

A review of bilingual education programs worldwide found that schools that are organised to support children's first language result in cognitive, social and educational advantages for their bilingual students. Programs that teach English at the expense of the first language, by contrast, produce negative cognitive,

social and educational outcomes for these students. For bilingual students, the most effective programs are bilingual, particularly if these aim to maintain and build up the first language. Less effective are integrated EAL/D programs, then EAL/D withdrawal programs, with English-only programs the least effective (May, Hill & Tiakiwai, 2004). This may be because strength of the first language supports the learning of a second, with considerable knowledge about language and the way it works already in place (Lightbown & Spada, 2013). Children for whom English is a second language tend to learn English and other subjects more effectively when their first-language skills are strong (Cummins, 1979; Thomas & Collier, 1999). The majority of programs in Australian and New Zealand schools involve EAL/D withdrawal or integrated EAL/D, although there are some schools with bilingual programs supporting Aboriginal languages and *te reo* Māori, as described in Chapter 11.

EAL/D learners may be of any age, with differing levels of cognitive development and skill in their first language. In addition, they may differ in their experience of English prior to starting school. Thus, effective evaluation and teaching programs are marked by flexibility. Rather than being guided by a specific developmental path, teachers focus on students' needs.

EAL/D programs in Australian schools are currently of two types: intensive English programs for newly arrived migrants, and support programs in mainstream schools. The latter may be within classes, where specialist and general classroom teachers support the development of English while studying the curriculum; or in withdrawal situations where English may be the sole focus (Scarino, Vale, McKay & Clark, 1988). For migrants in New Zealand, there are intensive English classes, with some immersion in mainstream English classrooms, to ready these students for mainstream classes once the intensive class ends (New Zealand Ministry of Education, 1994).

Immersion and bilingual programs in *te reo* Māori are also run in New Zealand schools, at levels ranging from whole-school immersion to bilingual units within schools. These were introduced in the 1980s following concerns that the language was diminishing in use (May, Hill & Tiakiwai, 2006). In a review of these programs, May, Hill and Tiakiwai urged that students need to be taught a language (such as English or *te reo* Māori), and to be taught in that language, so that they develop *academic* English or *te reo* Māori.

LITERACY DEVELOPMENT

Traditionally, **literacy** has been conceptualised in terms of the written language skills of reading and writing, but as our society becomes more technological, the written word is used in increasingly wider contexts. More recent approaches to literacy have also recognised the close relationship that reading and writing have with listening, speaking and viewing.

literacy
Engaging with various kinds of texts, and using and modifying language for use in a variety of contexts

The Australian Curriculum identifies literacy as a general capability underpinning learning. It states, 'Literacy involves students in listening to, reading, viewing, speaking, writing and creating oral, print, visual and digital texts, and using and modifying language for different purposes in a range of contexts' (ACARA, 2012b). The New Zealand literacy and numeracy strategy is even broader than this. It defines literacy as 'the ability to use and understand those language forms required by society and valued by individuals and communities' (New Zealand Ministry of Education, 2002). How does this add to our understanding of literacy?

Have you ever noticed how your use of English changes depending on where you are and who you are with? You may be more casual with your family, and more formal when you need to give a presentation to a group; teenagers often speak in particular ways with their peer group (Gee, Allen & Clinton, 2001). Similarly, your handwriting, grammar and even spelling probably differ when writing lecture notes, and when writing a letter to a friend, an essay, an email message or a text message. We use different forms of English in different contexts, and we need to adapt our language to the use we are making of it. Similarly, along with a variety of texts, there is a wide range of ways in which we interact

multiliteracies
The variety of types of language we need to master to be literate in our society

with texts. The way you read a website is different from the way you read a book, which is different again from how you read a shopping list, or watch a television program. **Multiliteracies** is the term that has been used to refer to this variety in types of language we need to master to be literate in our society (Cope & Kalantzis, 2000; Zammit & Downes, 2002).

THINK ABOUT

- How can we broaden the range of literacies taught in the classroom?

Learning to be literate

Reading and writing print are two key literacy skills. We have seen a number of features and practices in language development that later contribute to literacy development. Although children commonly learn to read and write once they are at school, many precursors of these skills are developed in the preschool years.

Emergent literacy

emergent literacy
Understandings about and attitudes towards reading and writing, which are the precursors of acquiring those skills

Early awareness of literacy has been termed **emergent literacy** (Clay, 1991). This includes understandings about conventions of print, such as the left–right, top–bottom ordering of print on a page in English, and the knowledge that letters represent sounds and are combined to form words separated by spaces. It also includes attitudes about the purposes and value of reading and writing.

Activities such as looking at books, reading environmental print such as street signs or the title of a favourite television show, and simple rhymes and songs all contribute to reading, as does writing. Similarly, writing is developed through reading and activities such as drawing and telling stories, as well as adult-supported writing such as writing a letter, a birthday 'wish list' or a story dictated by the child. A child's home environment is an important contributor to emergent literacy, in terms of both direct and indirect literacy support from parents. For instance, a relationship has been demonstrated between children's reading ability and such features of the home environment as length of family meal times (Anderson, Wilson & Fielding, 1988), number of books in the home, library membership and the amount that parents (and particularly fathers) read (Share et al., 1983), as well as more direct activities such as parents or other family members reading books with the child (Raikes et al., 2006). This is by no means an exhaustive list. There are many different literacy practices in families, including direct activities to teach literacy and all the informal ways in which reading and writing occur. Literacy also builds on language development, so language activities such as talking and listening are themselves important preliteracy activities. Diehl (2014) explained that good oral language supports literacy, while literacy activities themselves contribute to oral language development. This reciprocal relationship continues throughout development, as we will see. Indeed, neurological research has linked the development of children's oral skills though storytelling and conversation with later academic and literacy achievements (Sousa, 2005). Clearly, there is a wide range of activities that contribute to literacy development, some of which are direct, and some indirect. Snow and Kang (2006) observed that children use emerging literacy skills alongside and in similar ways to other developing skills: in play, to communicate, as part of everyday routines, and as problems to solve.

Teachers need to recognise the literacy skills and experiences that students bring from home, which may differ from those of the school, and to work with these. The closer the match between the literacy practices of home and school, the better chance there is of good literacy outcomes at school (Comber et al., 2005). There can be a mismatch between home and school literacy practices. Some projects aim to add to the home literacy experiences of children to improve the match (for example, Bochner & Freeman, 2002). Others have suggested that teachers should acknowledge the knowledge and skills their students do have, so that students can make use of what they know to develop their literacy (Comber et al., 2005). McNaughton (2002) has identified rich literacy resources in families in low

socioeconomic areas in New Zealand, which he suggested could be harnessed for their literacy learning in schools. Families would benefit from a combination of these approaches, both providing a bridge from family to school practices, and building up and broadening home literacy.

Literacy development throughout the school years

We sometimes think of literacy as something learnt in the early years of schooling, and those years are certainly important, but literacy learning also continues beyond Year 2. Consider the literacy skills students need for researching topics in upper primary school, or for preparing essays during secondary school, or the further learning you have done about how to read and write academic texts since starting university. The purpose of reading and writing changes, as well as the types of texts. Chall (1996) described a shift in reading development from 'learning to read' in the early years to 'reading to learn' in the later years of schooling. These skills need to be taught as carefully and explicitly as those in the early years. They also rest on those early literacy and language skills – another example of development building on what has gone before. For this reason, some students in upper primary and secondary schools may need to consolidate basic skills in reading ('learn to read') before they can effectively 'read to learn'.

Learning to read and write

There are many possible paths to literacy (Clay, 1998). Different children learn to read and write by different means (see Box 2.8). Here, we describe the development of skills used in reading and writing, focusing particularly on the aspect of literacy that is described as 'code breaking' (Freebody & Luke, 1999) or 'decoding'. Some other skills are described under the heading 'Teaching literacy in schools'.

Reading and writing are complex skills that involve the coordination of a number of individual skills. For expert readers, reading tends to be automatic, but for children the process is demanding and a little like solving a puzzle in code. Readers must simultaneously recognise the pattern of marks on the page as letters, decode individual letters as sounds, group strings of letters together to form new sounds, and check the word formed against their vocabulary – and that is just to read one word! As readers continue the process with subsequent words in a sentence, they must keep each word in their working memory so as to combine it with the other words in a meaningful way, and attend to punctuation to obtain clues about intonation and stress. It is little wonder that comprehension is often set aside as children tackle the complexities of decoding. The information-processing approach (see Chapter 3) describes reading as an information-processing problem that makes demands on working memory. The individual skills must become automatic in order for working memory to operate efficiently, or reading performance will be affected (Perfetti, Yang & Schmalhofer, 2008).

Once reading becomes more automatic, attention is increasingly focused on a variety of purposes, so that rather than 'learning to read', children start to 'read to learn' at around nine years old (Chall, 1996). In primary school, children progress from reading aloud to silent reading, and show increases in 'sight vocabulary' (the number of words they can recognise automatically) that affect fluency. The purpose of reading expands from reading simple stories to reading to obtain new information. At school, students don't just read, but also use reading as a tool for study. Going into adolescence, there are further increases in fluency and in the ability to read complex, unfamiliar and abstract texts. The range of materials and viewpoints further expands. This builds on learners' ability to go beyond the literal meaning and consider multiple viewpoints, and to draw inferences from a text with the development of abstract reasoning (see Chapter 3). By the end of school, many students define the purpose of reading for themselves, and are able to integrate their own viewpoint with that of the writer. Decoding skill is automatic and efficient, allowing for these broader functions of reading (Ely, 2005). Similarly, in writing, children progress from focusing on form to using writing as a tool. For example, Jacob enjoyed playing 'cafes' with his family, taking down each person's order on a notepad. To begin with, when Jacob was four years old, the orders

CourseMateExpress

Online resources
Go Further: See samples of Jacob's writing on this text's CourseMate Express website.

BOX 2.8 CASE STUDY

BEGINNING TO READ

Case study A

Anna loves to read, picking up books whenever she can. Her mother reports that Anna used to 'read' to the family dog, telling stories from her picture books, from about three years old. Anna's teacher reports that she is moving quickly through the school readers, picking up new words by sight and making sense of what she reads even when the words are difficult for her to sound out. Anna writes long sentences in her 'journal' (a scrapbook students spend time writing and/or drawing in each day), and many words are written with standard spelling, though she hasn't 'learnt' them formally.

Case study B

Fred participates in all the literacy activities in his kindergarten class. At home, his mother was reading *The Lion, the Witch and the Wardrobe* to the children in the evenings. At an exciting point in the adventure, the readings were interrupted for a few nights. To her surprise, Fred picked up the book and finished it himself. He was able to read well beyond his years before anybody had noticed, seemingly learning to read overnight.

Case study C

Josie also likes to look at books, but she enjoys them best when they are being read to her. Her teacher reports that she didn't understand the connection between the letters on the page and the words read out loud until it was clearly explained to her. The phonics program in her class is helping Josie to make this connection, and to be able to sound out words herself. Josie is also learning to read a bank of words by sight, to help her reading to become more automatic. Josie's journal entries are usually pictures, but she is starting to write sentences as well, inventing spelling by joining sounds together that she hears in the words. Occasionally, she copies words from word banks around the room.

Case study D

David is mystified by some of the reading activities at school. He doesn't yet hear individual sounds in words, so is not ready for the school's phonics program. A teacher aide works with David to develop his phonemic awareness. In his journal, he writes in scribbles, copying the children around him by making marks on the page, though he doesn't yet connect those marks to the specific shapes of letters.

ACTIVITIES

1 How does the reading development of these four children differ?
2 What would you do, if you were the teacher, to support each child's reading development?

were a series of scribbles on the page. Later, Jacob progressed to writing strings of letters and numbers. By the time he was six years old, his letters approximated the sounds they are meant to make, and others could read what he had written.

With further formal instruction at school, children's spelling and punctuation become more standard. There is a wide age range in children's development of these skills: in the same kindergarten class there may be one child still writing in unrecognisable scribbles, while another is writing elaborate stories.

In parallel with developments in their reading, children in middle childhood start to use writing as a learning tool to help make sense of information or events (Daiute & Griffin, 1993). Instruction becomes focused on writing for different purposes (genres) as children become more proficient and their understanding of other perspectives improves.

In adolescence, writing shows more complex syntax, better planning and editing, and an increasing depth of topic. The earlier focus on the mechanics of the writing process is replaced in these older learners by the ability to phrase things in their own words and to adapt their writing for a variety of purposes and audiences (McDevitt & Ormrod, 2013).

Teaching literacy in schools

Teachers make an important contribution to students' literacy throughout the school years (Comber et al., 2005).

There are many developmental pathways to literacy, and there is no 'best' way to teach literacy. Different aspects of literacy development require different inputs, with phonemic awareness and letter knowledge vital for decoding, while vocabulary and grammar skills contribute to reading comprehension (Adams, 2011). Reading practice contributes to the automatic, high-speed retrieval that is vital for reading skill, and exposure to print is fundamental to reading development (Snowling & Gobel, 2011). Indeed, the best way to ensure that all students have the skills they need across a range of contexts is to combine a number of approaches. You may have heard of approaches to literacy teaching such as the phonics, whole language, genre, functional or critical literacy approaches. Combining a number of such approaches in a balanced program appears to create the best outcome for the greatest number of students (Deakin University, 2005). Box 2.9 gives an example of such a combined approach.

BOX 2.9 CLASSROOM LINKS

Center (2005) recommended a balanced approach to the teaching of reading, balancing the systematic teaching of phonics with teaching children to make meaning from texts. These skills need to be combined so that children have the skills both to decode the text and to make meaning from the sounds and words they decode. In the first year, she suggests that teachers:

- read a variety of texts daily with the children to develop listening comprehension, vocabulary, knowledge and enjoyment of the reading process
- read texts interactively, including predicting, discussing and retelling the story
- use Big Books (large-format texts) to develop print awareness
- explain to children how learning individual sounds will help them to read all the books they encounter
- introduce each sound over the year, helping children to identify them in words, and to write them
- give children 'decodable texts' (that is, readers with simple text using the sounds the children can recognise)
- have other books available for children to read and have read to them
- develop phonemic awareness through activities such as thinking of words starting with a sound, blending sounds together to form words, and pulling words apart orally to separate phonemes
- encourage children to write in response to literature and to put in practice their phonological knowledge and skills
- teach spelling systematically to support children's reading and writing skills
- start to teach syntactic awareness
- include plenty of oral language activities, particularly for students of language backgrounds other than English.

Source: Adapted from Center, Y. (2005) *'Beginning Reading', a balanced approach to literacy instruction during the first three years of school.* Sydney: Allen and Unwin.

ACTIVITIES

Interview a teacher about their approach to teaching reading, and think about the skills that are being developed.

CourseMateExpress

Online resources

Go further: Explore the value of teaching skills and context in reading.

Luke and Freebody (1999) developed a model of the resources that literate people draw on to make meaning from and in texts. The resources are interdependent, so although there are four families of resources, each of these is necessary for literacy, but is not sufficient on its own. The resources reflect the four practices of literate people as code breakers, participants, users of texts and analysts of texts.

- *Code breakers* combine knowledge of graphophonic cues, spelling and grammar with other cues to meaning, such as pictures and context, to decode or create a text. A number of studies have shown the importance of explicit, systematic teaching of phonics to reading fluency and comprehension (de Lemos, 2002). Diehl (2014) listed phonemic awareness, phonics, reading fluency, vocabulary and text comprehension as supportive of literacy skills in the primary school years.
- *Participants* apply their knowledge of culture and society to make meanings in texts. Research has shown that the teaching of skills needs to occur in meaningful contexts, as reading is a purposeful activity (Comber et al., 2005).
- *Users of texts* are able to recognise and use different genres of text for different purposes. The functional approach (Gibbons, 2014) teaches about what texts do, and how different text types are structured and defined. Students' attempts to write for particular purposes are supported by modelling and guided practice.
- *Analysts of texts* read between the lines to judge the point of view of the writer, and to write for particular purposes themselves. Critical literacy is particularly important in the later years of schooling, as students select between a number of resources, judge the appropriateness and validity of what they read, and write for particular audiences. This skill is highlighted when searching for information on the Internet, for example.

Teachers can contribute a range of practices within each resource family to each student's repertoire. As different students will use different practices in different contexts, having a range of practices available within each resource family is important. In a classroom reading lesson, you might see students learning to associate letters with their sounds and to blend sounds, predicting what will come next, taking part in a shared reading activity in which they talk about a book and what it is about, sequencing text, reading alone, reading aloud to someone else, rewriting a story to put it into a different context, exploring the structure of a fairytale, writing a response to a story they have read, using the computer to find out what others have thought of the story, and talking together about the story and what they liked or disliked about it. In another classroom, students might be looking at a different kind of text on a website, reading pictures and icons to navigate through the site, judging the truthfulness and relevance of what they've read, linking to other sites, talking together about what they want to find out and where and how they might find it, and discussing why different sites give conflicting 'facts' and how to determine which is correct.

Source: Compassionate Eye Foundation/Chris Ryan/Getty Images

FIGURE 2.15 Literacy activities may involve a range of reading, writing, speaking, listening and viewing activities. All these contribute to literacy.

NUMERACY DEVELOPMENT

numeracy
The ability to use mathematics effectively and with confidence in a range of contexts

Numeracy is often used as a partner term to literacy. The New Zealand Ministry of Education (2009a) uses the following definition: 'To be numerate is to have the ability and inclination to use mathematics effectively – at home, at work and in the community'. The Australian Curriculum (ACARA, 2012b) states that 'numeracy involves students in recognising and understanding the role of mathematics in the world and having the dispositions and capacities to use mathematical knowledge and skills purposefully'.

It involves mathematics, but goes beyond the mathematics classroom to be involved in all curriculum areas. Numeracy is identified as a general capability addressed across the Australian Curriculum. It is conceived as having six elements: estimating and calculating with whole numbers; recognising and using patterns and relationships; using fractions, decimals, percentages, ratios and rates; using spatial reasoning; interpreting statistical information; and using measurement (ACARA, 2012b).

Just as literacy is thought to be intrinsic to everyday functioning in our society, numeracy is also recognised as a key skill for learning and life. In 2008, the Australian Government set goals for literacy and numeracy that included: 'All young Australians become successful learners: have the essential skills in literacy and numeracy … as a foundation for success in all learning areas' (MCEETYA, 2008). New Zealand's *National education goals* similarly state: 'Priority should be given to the development of high levels of competence (knowledge and skills) in literacy and numeracy' (New Zealand Ministry of Education, 2004).

Bryant and Nuñes (2011) identify three main contributors to children's mathematical knowledge and understanding: their development of logical thinking (see Chapter 3 for more on this), meaningful experiences with quantity and number, and teaching of conventional systems such as counting. We will see examples of each of these contributors as we look at the development of numeracy throughout childhood and adolescence.

Emergent numeracy

As with language, awareness of mathematical principles seems to be biologically determined. Research with infants shows that they are aware of quantity from the first days after birth, recognising changes in numbers of small sets of objects (Antell & Keating, 1983). By the time they are two years old, children also show expectations that adding something will increase an amount, and that taking something away will decrease it (Sophian & Adams, 1987).

These early understandings are built upon by the developing child's experiences in the physical and social world. Look around you: almost unconsciously, you may notice that the level of tea in your cup is lower than it was earlier, that there is less text on this page than on the last, that the hands on the clock have moved from four towards five. We operate in and are surrounded by a world of quantities, measurements and spaces. Children's daily experiences habituate them to think about mathematical constructs. Stacking blocks and fitting cups inside one another help understandings about seriation to develop; playdough and sand and water play all help to develop understandings about quantity, and helping pour and mix in real or pretend cooking, or comparing the size of dessert portions to ensure the ice-cream is divided 'fairly', contribute to understandings about measurement. In addition, activities and the games parents play with young children help them to learn the number names, as well as ideas about quantity, size and shape. Rhymes such as 'one, two, buckle my shoe' are examples, as is the common game of walking or jumping up and down steps, counting as you go (see Figure 2.16). As children get older, these everyday activities change, but can still contribute: games with dice and cards help children to 'subitise' numbers – immediately recognise the number of items in a group – while setting the table for dinner develops an understanding of one-to-one correspondence. Still later, working out probability while playing a card game or watching a television game show, estimating costs for a mobile phone, comparing prices for items bought in the supermarket, and translating recipes from imperial to metric

Source: © Corbis/Claudia Rehm/Westend61

FIGURE 2.16 Children's informal activities and games help them to learn about numbers.

measurement, or adjusting quantities in a recipe for a larger or smaller number of people, continue to draw on and develop mathematical understandings.

Learning to be numerate

The role of language

Numeracy also builds on children's language development. LeFevre et al. (2010) showed that foundation skills in language (phonological awareness) predicted early mathematics performance, while Austin, Blevins-Knabe and Lokteff (2013) found a relationship between the language skills of letter awareness, letter sounds and name writing, and scores in early mathematics ability. Ginsburg, Klein and Starkey (1998) pointed out that students without a vocabulary for mathematics have the most difficulty in understanding numeracy. Developing a vocabulary to describe numbers, shapes and measurements, and to explain how a mathematical problem might be solved, forms an important part of early numeracy activities in preschool and school. Children start with informal ways of describing mathematics, gradually developing more formal and specialised mathematical language as they move through primary and secondary school. Language is central to developing an understanding of mathematics (Anthony & Walshaw, 2007). Children are encouraged to talk about their strategies to explain how they arrived at an answer, and to describe their observations in mathematics classrooms (Bobis, Mulligan & Lowrie, 2013). This can involve oral and written language, as well as pictures and symbols. It helps children to make sense of their ideas and to learn to communicate their understandings, as well as to develop the important belief that mathematics is something that is not just transmitted (taught) by a teacher, but can be discovered, constructed and elaborated by each person. It can also help teachers to assess students' understandings. In Figure 2.17, a child describes his strategies in solving two maths problems, which enables the teacher to see his thought process and to guide him.

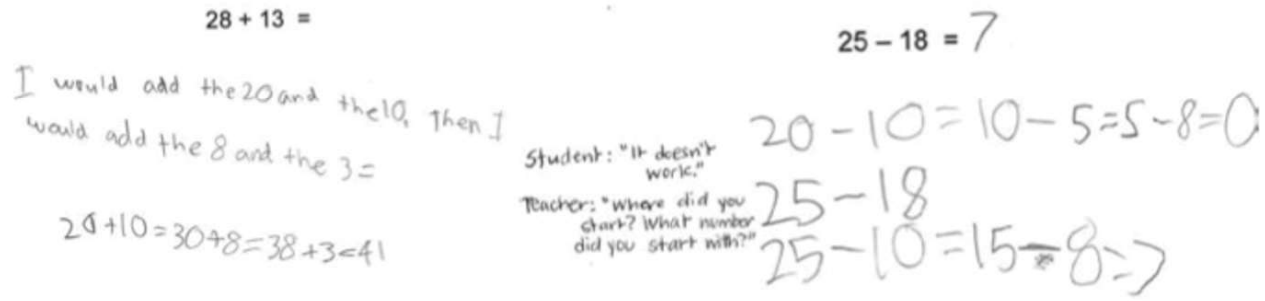


FIGURE 2.17 Children's explanations of strategies in number help them develop their thinking, and allow teachers to guide the process.

The child's role

As in language acquisition, children are active in developing mathematical understandings and strategies for operating in their world. These strategies increase in complexity and effectiveness with age (Baroody, 1987). For example, by about four years of age, children use a counting strategy to combine groups of objects: 'one, two … three, four (2 + 2)' (Ginsburg, Klein & Starkey, 1998). Such strategies for addition and subtraction appear spontaneously before the child starts school. These strategies are later extended by combining counting and the use of memorised number facts ('one and one is two … three, four, five (1 + 1 + 3)'), then by more sophisticated strategies such as recombining or restructuring numbers to simplify a problem ('nine and one are 10 and six are 16 (9 + 7)'). Children are able to apply strategies first with concrete objects they can see, then with invisible objects ('doing it in your head'). You may see why this is so in the description of Piaget's theory in Chapter 3. There is evidence that these strategies

are constructed by the child, as well as being taught formally in school (de Corte & Verschaffel, 2006). Just as children's errors in language show their developing understanding, the errors children (and adults) make in number are testimony to their own role in constructing their strategies and knowledge about mathematics (see Figure 2.18 for an example). Helping students to become aware of their strategies, by asking them to explain and justify how they solved a problem, along with sharing and comparing strategies with other students, contributes to their abilities to evaluate and improve their learning. Table 2.1 gives a developmental framework for numeracy that identifies how strategies change with development. Such knowledge can help teachers to identify the counting strategies students are currently employing, and to help students to develop more advanced strategies.

Numeracy involves more than just number sense: the development of children's understanding of space, shapes and measurement has also been described, and has connections to art, science, engineering and making sense of the visual world around us (Bobis, Mulligan & Lowrie, 2009).

Numeracy in the classroom

Children's exposure at school to more formal systems, with written rules and procedures, parallels learning to read and write, and the formal systems of language. The informal mathematics developed before school provides children with an important base on which to build new understandings. As with reading and writing, the challenge for teachers is to help children connect their informal understandings with new ways of thinking about and representing mathematics. One way in which teachers do this is with the use of concrete materials.

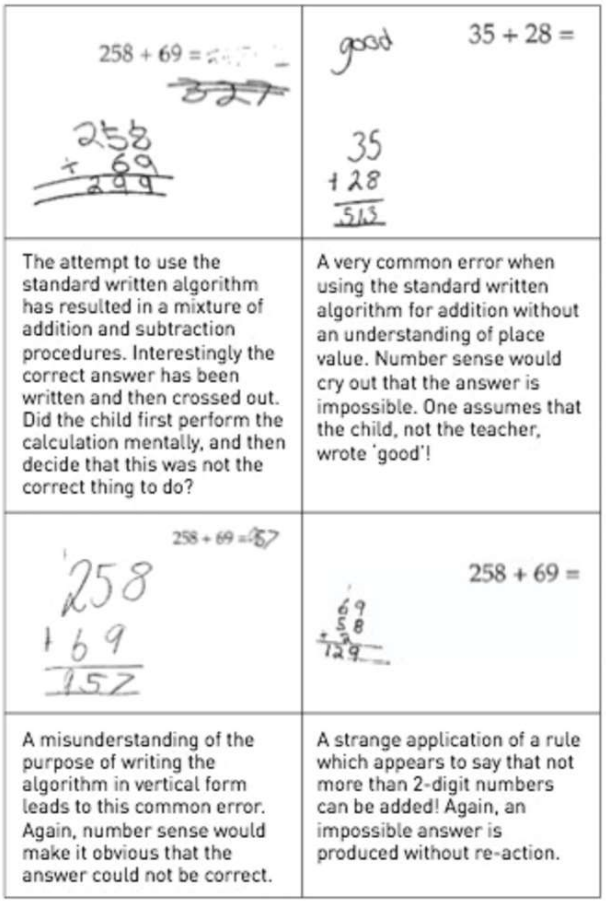


FIGURE 2.18 Common student errors when using algorithms without understanding.

Source: McIntosh, A., *Developing Computation*. Hobart: Department of Education Tasmania, 2005. © Commonwealth of Australia reproduced by permission.

Children are faced at school with the task of learning formal systems for representing numbers: for example, that twenty-four is written as '24' and not as it is said ('20-4'). Children also learn formal ways of carrying out operations with number, such as in algorithms for addition and subtraction, or the procedure for long division or for multiplying numbers with more than two digits. Recent approaches to the teaching of numeracy in Australia and New Zealand focus on building connections between students' understandings and formal ways of doing things. They do this by developing students' understanding of mathematics using concrete materials such as fingers, blocks and counters, then encouraging the students to develop mental operations ('doing it in your head') and exploring strategies for operating with numbers, before using formal written approaches such as algorithms (for example, see McIntosh, 2005; New Zealand Ministry of Education, 2005). McIntosh points out that common student errors with algorithms result from their use of them as a formula, without understanding (see Figure 2.18). He suggests that when students develop their own written strategies for addition and subtraction, the connections with meaning are less likely to be lost. Sharing strategies for solving problems helps students to articulate their thinking, as well as recognise other ways of approaching a task.

Parents and others sometimes express a concern about when number facts will be learnt under this approach. There is still a place for the learning of number facts (addition and multiplication tables), but

TABLE 2.1 The number framework

Stage 0: Emergent	The student is unable to consistently count a given number of objects because they lack knowledge of counting sequences and/or one-to-one correspondence.
Stage 1: One-to-one counting	The student is able to count a set of objects or form sets of objects, but cannot solve problems that involve joining or separating sets.
Stage 2: Counting from one on materials	The student is able to count a set of objects or form sets of objects to solve simple addition and subtraction problems. The student solves problems by counting all the objects.
Stage 3: Counting from one by imaging	The student is able to visualise sets of objects to solve simple addition and subtraction problems. The student solves problems by counting all the objects.
Stage 4: Advanced counting	The student uses counting on or counting back to solve simple addition or subtraction tasks.
Stage 5: Early additive part-whole	The student uses a limited range of mental strategies to estimate answers and solve addition or subtraction problems. These strategies involve deriving the answer from known basic facts (for example, doubles, fives, making 10).
Stage 6: Advanced additive/early multiplicative part-whole	The student can estimate answers and solve addition and subtraction tasks involving whole numbers mentally by choosing appropriately from a broad range of advanced mental strategies (for example, place value partitioning, rounding and compensating, or reversibility). The student uses a combination of known facts and a limited range of mental strategies to derive answers to multiplication and division problems (for example, doubling, rounding or reversibility).
Stage 7: Advanced multiplicative part-whole	The student is able to choose appropriately from a broad range of mental strategies to estimate answers and solve multiplication and division problems. These strategies involve partitioning one or more of the factors (for example, place value partitioning, rounding and compensating, or reversibility).
Stage 8: Advanced proportional part-whole	The student can estimate answers and solve problems involving the multiplication and division of fractions and decimals using mental strategies. These strategies involve recognising the effect of number size on the answer and converting decimals to fractions where appropriate. These students have strongly developed number sense and algebraic thinking.

this follows work with numbers so that those facts are meaningful rather than simply a rhyme learnt by rote. Just as with reading, being able to retrieve the facts automatically frees up short-term memory for processing other aspects of a problem. As you can see in Table 2.1, it also allows students to recombine those facts to solve more complex problems.

Numeracy across the curriculum, throughout schooling

Just as with literacy, numeracy is a skill that is used throughout life and, like literacy, numeracy concepts should be addressed across all curriculum areas and at all levels of schooling. Stephens (2000) argued that the abilities described in the definition of numeracy above are addressed differently at different levels of schooling. Development of number concepts and counting or arithmetic skills are emphasised in the early years, and in the middle primary years this is broadened to competence in working with number and applying numeracy in other curriculum areas. In secondary schools, Stephens points to the need for students to make links between what is learnt in the classroom and its practical application in other social, personal, education and work contexts. There is a parallel here to the work in literacy, with

a number of interrelated sets of skills being required for functional numeracy to occur. The research project *Numeracy across the curriculum* looked at students' numeracy skills applied in other curriculum areas during primary school (DEST, 2007). Figure 2.19 gives examples of tasks or problems from other curriculum areas in which students need to be numerate – to apply their knowledge of mathematics. The researchers found that students didn't always recognise how their mathematics needed to be applied to solve the problem, had difficulty applying what they knew, and lacked confidence in using mathematics to make sense of the problem. They suggest that teachers can help students to apply their mathematical knowledge and skills by:

1 capturing the numeracy in the moment
2 considering the numeracy demands of tasks and the range of students' strategies for approaching them
3 allowing students to work it out for themselves, individually or with others
4 giving time for students to engage with the numeracy demands, ask questions and fully understand the lesson
5 using open-ended questioning to support students' development of understanding and to encourage discussion
6 supporting students' enthusiasm to explore a concept, rather than teaching the skill first, then doing the activity
7 listening purposefully, and questioning to monitor students' numeracy knowledge and skills
8 debriefing, with open questions encouraging reflection on how mathematics was used and how it helped them to learn, understand and solve the problems.

Science
Length of a hammerhead shark:
A nature video stated a shark's length as 19 feet. Nineteen feet of tape was placed on the floor to assist in visualising the shark. A comparison of the imperial measurement of feet to the metric metre was used.

Technology & Enterprise
Jelly-making:
Students had to divide jelly into four equal portions. They then costed the ingredients and worked out how much profit the canteen made on jelly sales.

LOTE
Making flags:
Students worked in groups to make the flag of a particular country. Measuring, approximating and halving skills were involved.

Health & Phys Ed
Obesity in children:
A newspaper article reported that 24% of children are overweight. The class discussed the statistic and related it to the number of students in the class.

English
Creating a story map:
While watching a popular and exciting film, students noted that the events built up to a climax. Later, after discussing the film, they illustrated the building excitement on a line graph.

Society & Environment
Mapping:
The students were asked to locate Meekatharra in their atlases and then describe its position. They responded by saying it was near another location rather than using latitude and longitude. This generated discussion on reading latitude and longitude on a map for accurately locating a site. Scale was also used to determine distance.

Art
Making an envelope for a 3D card:
The students made a net of an envelope that would fit the 'minibeast' card they had made. Measurement and accuracy were expected.

School Life
Lunchtime cricket:
A roster was drawn up by a group of students for the use of the classroom cricket bat. Names were drawn from a hat so there was fair and equal access to the bat for all students.

FIGURE 2.19 Students' mathematics knowledge is called upon in many different curriculum areas.

BOX 2.10 CLASSROOM LINKS

EFFECTIVE PEDAGOGY IN MATHEMATICS

Anthony and Walshaw (2009) identified from research the following principles for effective mathematics teaching. They emphasised that the principles are interrelated, working together to engage learners in mathematics learning. They sit within wider family, school, community and education system practices.

1 *An ethic of care:* With a focus on mathematical goals, effective teachers encourage model sharing and evaluation of ideas, which allows students to develop confidence in themselves as learners and mathematicians, and to take personal responsibility for their learning.
2 *Arranging for learning:* Students are given opportunities to work independently, as well as in pairs or small groups and as a whole class, as they make sense of mathematical ideas. Each of these modes offers different benefits for learning.
3 *Building on students' thinking:* Effective teachers start with students' current knowledge, interests and abilities and use them as a platform to develop further understanding. Real tasks can help to expose students' thinking, and to extend it. Misconceptions are viewed as steps on the way to full understanding, and are used to develop further opportunities for learning. Starting with students' current level of understanding enables effective teachers to adjust teaching to provide an appropriate level of challenge for each student.
4 *Worthwhile mathematical tasks:* Tasks are selected that require students to use mathematical concepts and to think in mathematical ways. The same task may provide opportunities for practice, while also presenting a challenge and provoking thought.
5 *Making connections:* Making meaningful links between different mathematical ideas contributes to conceptual knowledge. Being able to represent concepts in multiple ways similarly helps with flexible thinking and conceptual development. Effective teachers also help students to connect mathematics to their life experiences, and new knowledge to existing knowledge.
6 *Assessment for learning:* Effective teachers use a variety of strategies to assess students' understanding. They make use of this information to guide instruction, give feedback that informs students about how they can improve, and encourage students to evaluate their own work. (See Chapter 13 for more on assessment for learning.)
7 *Mathematical communication:* Effective teachers encourage students to explain their strategies and justify solutions. They model and explicitly teach students how to do this, and set up situations in which students take opposing viewpoints and defend their ideas to help them to develop the appropriate communication skills.
8 *Mathematical language:* Mathematical terms are taught explicitly and modelled, with links made to home language and to everyday concepts.
9 *Tools and representations:* A range of tools and representations link to mathematics: some examples are the number system, graphs and charts, number lines, formulae, concrete materials, student-made pictorials and ICT tools (see Chapter 12). Careful selection of tools supports students' visualisation, mathematical reasoning and conceptual understanding.
10 *Teacher knowledge:* Teachers' knowledge of mathematics helps them to judge students' level of understanding and where to take them next, what they need to teach and how to teach it, and to connect concepts and ideas in multiple, complex ways. They can anticipate likely misconceptions and respond to them in ways that move students' understanding forwards.

Source: Adapted from Anthony and Walshaw (2009).

ACTIVITIES

1 Think back to your own learning of mathematics, or to a mathematics classroom you are familiar with. How were these principles evident (or absent)?
2 Describe what a classroom that operates on these principles would look, sound and feel like.
3 Compare these principles with the principles of effective pedagogy in mathematics given in the above box.

Box 2.11 looks at the classroom implications of skills development. Vygotsky's work, described in Chapter 3, may help you think about how to assess children's abilities and how to take account of these in your own teaching. Chapter 13, which deals with assessment, contains further strategies that might be helpful.

CourseMateExpress

Online resources
Go further: See a case study of these principles (outlined in Box 2.10) put into action to improve mathematics achievement for diverse learners.

BOX 2.11 IMPLICATIONS FOR EDUCATORS

DEVELOPING CHILDREN'S SKILLS FOR SCHOOL

- Supporting EAL/D learners is important to their success, not only in English, but also across the curriculum.
- Encouraging children to think and talk about new concepts in their native language can help them acquire the concepts and learn to express those concepts in English.
- Involving parents in the classroom and encouraging them to talk to children in their own language can help facilitate the process of acquiring and expressing concepts in English.
- Students bring important skills and knowledge to their learning, as well as attitudes about particular subjects or skills and about learning itself.
- Recognising students' past experiences is important for accurately matching teaching to students' abilities and experiences.
- Current approaches to teaching language, literacy and numeracy take account of what the student already knows, in order to build new knowledge. (Examples of this in numeracy are the Mathematics K-10 Continuum of key ideas developed in NSW (NSW Department of Education and Communities, 2014), and the Numeracy Project in New Zealand (Ministry of Education, 2005), which aim to help teachers match teaching to students' number strategies.)
- Language is vital to the development of competence in second language, literacy and numeracy.
- There are connections between literacy, numeracy and other curriculum areas, which mean that these skills should be directly addressed in teaching, irrespective of the curriculum area.
- Literacy, numeracy and second-language competency are required, and continue to develop, throughout schooling.

PRINCIPLES OF DEVELOPMENT

In this chapter, we have examined the acquisition of a number of different skills in the domains of physical development, language, literacy and numeracy. Despite the range of domains and skills, some principles of development can be deduced that also apply across the cognitive and socioemotional domains discussed in Chapters 3 and 4. The principles are as follows:

- *Development involves a series of progressive and orderly changes leading to maturity.* Development involves change of a particular type, and is generally orderly (we learn to crawl first, then to walk, then to run). It is also directional: the changes, at least in childhood, tend to lead towards more complex, effective ('mature') behaviour. This trend towards complexity and more organisation is seen in all aspects of development, and reflects brain development.
- *Development is continuous but uneven.* One of the enduring debates in theories of development is about whether we describe it as continuous or discontinuous (see Box 2.12). Different areas of the body and brain develop at different times, as do different functions. In addition, there are watershed events in human development that create opportunities for significant shifts across multiple domains. These include independent locomotion (crawling and walking), language

acquisition, and puberty. Arguably, there are also cultural watershed events that similarly create opportunities for developmental shifts across domains. Starting school is an example in Western cultures.

- *Development is a lifelong process.* Although we develop at different rates in different areas, we can be said to be developing throughout the lifespan. Commonly, children's development is described as occurring in a number of stages: infancy (0–2 years), early childhood (3–7 years), middle childhood (8–11 years) and adolescence (12–20 years). You will recognise the age ranges associated with these stages in the descriptions of Piaget's theory in Chapter 3, and in Erikson's theory in Chapter 4. A number of researchers have noted the shifts that occur in children at about two to three years old, seven to eight years old and 11–12 years old – not only in cognitive development, but also in the social and personal areas. Growth spurts have also been observed in the brain at these ages. The shifts can be attributed to changes in both maturation and environment. Although there are physiological changes that occur in all cultures, the precise age at which the shifts occur varies due to environmental factors such as diet or cultural practices.
- *Development can vary from one individual to another.* The most obvious developmental variations occur between males and females, with girls tending to lead boys in physical development. Other group variations can be observed among different ethnic groups. There are many other sources of variability too. The chapters in Module III of this book examine a number of these sources in detail. In general, while genes play a role, the variability in development can be explained by looking at the forces affecting that development.
- *Multiple pathways of development.* These variations may be in timing, but they may also be in the pathways of development: the particular pattern of factors that contribute to development may vary as a result of contextual and individual factors. We have seen this in motor, language and literacy development.

Source: Laszlo Halasi/Shutterstock

FIGURE 2.20 There are multiple pathways of development, linked to individual differences in context and activity.

BOX 2.12 IMPLICATIONS FOR EDUCATORS

THINKING CRITICALLY ABOUT DEVELOPMENT

There are some enduring debates that distinguish theoretical approaches to development. As you consider the material in this chapter, and in the other chapters in this module, your own position on these issues of development may affect your personal philosophy as a teacher.

1 Is development continuous or discontinuous? Does it progress as an abrupt series of changes, like ascending a staircase, or in small increments, like going up an escalator? Continuous theories propose that children's behaviour and skills are less complex versions of what adults can do. With development, they gain more knowledge and practice, which contributes to gradual improvements in these skills and abilities. Discontinuous theories hold that there are qualitative differences between the ways in which children and adults think about and operate in the world. With development, children's thinking and behaviour undergoes radical, relatively sudden changes from one stage to the next.

2 Are the course and processes of development general or specific? Can we describe the same set of developmental processes for all people and for all domains, or do we need a separate picture of development for different skills, and for different contexts (perhaps for different

>>

people, or for people at different times in their lives)? Some theories seek to distil the basic processes of development that occur across all people, while others investigate the effects of different contexts on development. Some emphasise general processes across domains, while others propose that each area of development has its own process, particular to it.

3 Is development mainly influenced by innate or environment factors? This is the nature–nurture debate. Theorists who represent the 'nature' end of the continuum emphasise innate, hereditary influences, while those representing the 'nurture' position emphasise environmental influences. This question continues to divide theorists, although disagreements tend to be about the relative influence of the two sets of factors, rather than taking an extreme position that denies the influence of either set. There is evidence of both sets of influences in all aspects of development, irrespective of domain.

ACTIVITIES

1 Consider an example of development from your own experience or the experience of someone you know. Would you describe it as continuous or discontinuous? Compare others' experiences. Are your processes of development similar? Are they similar across domains (whether describing developments in physical growth and skills, language, thinking or emotion)? List what has influenced your development. What do you conclude?
2 Gather evidence in support of each of these approaches from aspects of development described in this chapter. What does the evidence suggest?
3 Go to the personal philosophy section of the student companion website and fill in your views. Return to these issues as you continue to study theories of development.
4 Think about how your position on each of these issues might influence your teaching practice.

CourseMateExpress

Online resources
Take a moment to consider your philosophy of learning and teaching. You may wish to use the **Develop your philosophy** tool on the textbook's CourseMate Express website.

WHAT CONTRIBUTES TO DEVELOPMENT?

This question of what contributes to development has been a major source of controversy for developmental psychologists. Theorists argue about the roles of maturation, learning, environment and culture (see Box 2.11). Yet, while the controversy continues about each aspect's relative contribution, few would argue for an extreme position that relied on or entirely excluded any one of these forces. The following points review some examples of each kind of influence from the domains discussed in this chapter:

- *Development results from both maturation and learning.* This position represents the nature–nurture debate discussed in Chapter 9. As we have seen, both innate and environmental forces combine to influence development across the physical and language domains. Other chapters in this module similarly illustrate the influence of a mixture of innate and environmental forces in development.
- *Development occurs in context and is influenced by environment.* There are environmental influences on language development in the social interaction children hear and are involved in. In terms of physical development, family and community activities and the formal activities of school contribute to children's motor skills.
- *Children are active in development.* Far from being something that simply 'happens' to children, development grows out of children's activity. For example, crawling produces changes in brain structure that support physical, perceptual and cognitive changes. Children actively try to make sense of language and of mathematics. These attempts may result in errors, but they are testimony to the important role children play in their own development in all domains.
- *Development is cumulative.* One change provides a basis for further change. In this chapter we have seen a number of examples of the close interaction between different dimensions of development. As one area develops, it changes the kinds of activities children engage in and their

relationships with those around them, providing new opportunities for development in other areas. One example is adolescents' capacity for abstract thinking, which changes the way in which they deal with their emotions. This in turn affects their friendships and influences their thoughts and behaviours.

Box 2.13 looks at a number of the implications for educators of considering the developmental principles.

BOX 2.13 IMPLICATIONS FOR EDUCATORS

CONSIDERING DEVELOPMENT IN THE CLASSROOM

- Because development is orderly and progressive, teaching must be tailored to children's developmental levels (that is, there is no point teaching calculus to preschoolers, or basketball to babies). This involves teachers being aware of the course of development across a number of domains. This chapter and others in Module I should help you develop such knowledge.
- Stages in development coincide with stages of schooling, in that middle childhood roughly coincides with the primary years, and adolescence with secondary schooling. Recognising developmental shifts that occur with age, some States and Territories in Australia further break these broad groupings into stages of two years each. The aim is that teachers plan learning and teaching strategies to match each student's developmental stage, and that students develop skills appropriate to their developmental level.
- Developmental variations are important for teachers to consider. One explanation of gender differences in literacy outcomes is the relatively slower development of language in boys. It has been suggested that boys should receive a different kind of literacy instruction to cater for this developmental difference (Rowe & Rowe, 2002). Chapter 11 explores this and other gender issues in greater depth.
- Because development occurs in context, what happens around children influences their development. It is important for teachers to consider not just what is taught, but how it is taught. Other environments children are involved in also influence their development through the experiences and knowledge provided. Teachers therefore need to know about children's home environments in order to effectively consider children's needs. Chapter 11 explores this issue in relation to culture and poverty.
- That children are active in development suggests that students should be mentally and physically active in their learning, too. For example, learners can be encouraged to make sense of how new and old experiences and knowledge fit together.
- Students make sense of their experiences. We can encourage this process in schooling by asking students to develop their own approaches to tasks before introducing them to standard methods.
- Development is cumulative, so it is important when teaching skills to build up from what students can do first, and towards the final goal. Identifying a number of steps or component skills in a complex task can help in this process. Task analysis, described in Chapter 5, is one approach to this strategy. Designing tasks that draw on skills from a number of areas can help students consolidate earlier achievements, as well as integrate, coordinate and apply their skills.

CONCLUDING COMMENTS

Development is influenced by genetics, environment and the activity of individuals themselves. Effective teaching therefore recognises each of the possible influences on a student's development. This chapter has explored these influences on physical and language development, and on the development of some school-based skills. In Chapter 3, we look at some theories of cognitive development.

CHAPTER REVIEW

- There are connections between physical, cognitive, language, social and emotional development throughout the lifespan.
- Maturation, parents, the community and school, and the child's own activity all contribute to motor-skill development.
- The development of fine and gross motor skills is important in early childhood, while middle childhood sees increased coordination and the combining of motor skills.
- Puberty is the major physical development in adolescence, presenting challenges to adolescents' self-image and family relationships. Individual differences in the timing of puberty affect adolescents' ability to adapt successfully to these changes.
- There are group differences in development due to environmental factors such as nutrition, and sociocultural factors such as gender-typed activity.
- Brain development also shows complementary influences from genetics, environment and the child's activity.
- Developmental increases in complexity and coordination of thoughts, feelings and behaviours are associated with structural neurological changes such as increases in neuronal size and complexity, as well as myelination, which improves the efficiency of message transmission.
- The course of first-language acquisition is remarkably consistent across cultural and language groups. It shows children's active involvement in their acquisition of language.
- Adults make important contributions to language development, which continue into a child's school years.
- The school-based skills associated with second-language learning, literacy and numeracy all build upon early developments in physical, motor and language skills, as well as the cognitive, social and emotional developments discussed in Chapters 3 and 4.
- Children's active involvement in making sense of their world shows itself in their understandings about language and number from the first days after birth. In schools, we build upon these early understandings and so need to be aware of and recognise them.
- Development is a series of progressive and orderly changes leading to maturity, which shows both consistency across humanity and also individual difference. Development is lifelong, with each change providing a basis for future changes.

ONLINE STUDY RESOURCES

CourseMateExpress

COURSEMATE EXPRESS

Visit http://login.cengagebrain.com and use the access code that comes with this book for 12 months' access to the student resources for this text.

The CourseMate Express website contains a range of resources and study tools for this chapter, including:

- a **self-check quiz**
- **crosswords**, **flashcards** and a **glossary** to help you revise the key terms from this chapter
- the **Go further** materials and **interactive activity** mentioned in the chapter.

SEARCH ME! EDUCATION

Explore *Search me!* education for articles relevant to this chapter. Fast and convenient, Search me! education is updated daily and provides you with 24-hour access to full-text articles from hundreds of scholarly and popular journals, ebooks and newspapers, including *The Australian* and *The New York Times*. Log in to Search me! through http://login.cengagebrain.com and use the search terms listed in the 'Education databases' section (page 75) as a starting point.

QUESTIONS AND ACTIVITIES FOR SELF-ASSESSMENT AND DISCUSSION

1 What are some influences on development? Describe this in relation to the development of a particular skill such as reading, learning to play the clarinet, or playing basketball.
2 Explain motor development in terms of contributions of brain, body and behaviour.
3 What variation in physical development exists between groups, and how can individuals' development be supported in schools?
4 Why does the number of neurons decrease with age after infancy? What role does learning play in this process?
5 How do adults contribute to language development? How can you apply this to the roles of teachers and parents in students' language learning in schools?
6 How are the development of literacy and numeracy both similar and different?
7 What aspects of physical, brain and language development support learning in school?
8 Describe how meaningful experiences, logical development, language and formal teaching contribute to the development of mathematical understanding. What implications does this have for you as a teacher of numeracy?
9 What are the three main debates in development research? Describe your position on each of these.
10 Identify a watershed developmental shift, the opportunities it presents for development, and the consequences for development in other domains.

KEY TERMS

adolescence
attachment
axon
brain plasticity
cerebral cortex
child-directed speech
dendrites
emergent literacy
expansion
fine motor skills
gross motor skills
joint attention
lateralisation
literacy
metalinguistic awareness
morphology
multiliteracies
myelination
neuron
neurotransmitter
numeracy
overextension
over-regularisation
phonology
pragmatics
puberty
recasting
semantics
synapse
syntax
telegraphic speech
underextension

PUTTING IT TOGETHER

MAKING LINKS BETWEEN 'EMERGING SKILLS' AND MATERIAL IN OTHER CHAPTERS

- Principles of development introduced in this chapter are also evident in cognitive, social, emotional and moral development, discussed in chapters 3 and 4. Consider how physical, brain and language development contribute to, and are influenced by, cognitive, social and emotional development.

FURTHER RESEARCH

RECOMMENDED READING

Berk, L. E. (2013). *Child development* (9th ed.). Boston: Allyn & Bacon.

Berko Gleason, J. & Ratner, B. (Eds) (2013). *The development of language* (8th ed.). Needham Heights, MA: Allyn & Bacon.

Levey, S. (2014). *Introduction to language development*. San Diego: Plural Publishing.

Lightfoot, C., Cole, M. & Cole, S. R. (2012). *The development of children* (7th ed.). New York: Worth.

McDevitt, T. M. & Ormrod, J. E. (2013). *Child development and education* (5th ed.). Saddle River, NJ: Pearson.

RECOMMENDED WEBSITES

Visit the website of your local department of education to look at their approach to teaching physical education, EAL/D, literacy and numeracy:
Australia: http://education.gov.au
New Zealand: http://www.education.govt.nz
Australian Capital Territory: www.det.act.gov.au
New South Wales: www.schools.nsw.edu.au
Northern Territory: www.education.nt.gov.au
Queensland: http://education.qld.gov.au
South Australia: www.decd.sa.gov.au
Tasmania: www.education.tas.gov.au
Victoria: www.education.vic.gov.au
Western Australia: www.education.wa.edu.au

Centres of neurological research relating to education:
Centre for Educational Neuroscience (UK): www.educationalneuroscience.org.uk
Science of Learning Centre (AUS): http://qbi.uq.edu.au/science-of-learning-centre

EDUCATION DATABASES

Search databases such as ERIC, PsycINFO and the Australian Education Index, using terms such as:

- brain development
- EAL/D
- language development
- literacy
- motor skills
- numeracy
- physical development
- second-language acquisition.

Adding terms such as 'early childhood', 'middle childhood' and 'adolescence' will limit the results to the age group you are interested in.

You can also use these terms as a starting point for exploring the **Search me! education** database mentioned above.