8

Children's numeracy skills

Galina Daraganova
Australian Institute of Family Studies

John Ainley
Australian Council of Educational Research

Numeracy, and the capacity to be numerate, is the ability to reason with numbers and to effectively apply mathematical concepts in everyday life (Ministerial Council for Education Early Childhood Development and Youth Affairs [MCEECDYA], 2008). A number of studies have suggested that early numeracy is grounded in number competence (such as recognising the value of quantities and grasping the principles of counting) (Jordan, Kaplan, Rameni, & Locuniak, 2009), informal number sense (e.g., understanding terms such as "more", "less", "bigger" and "smaller"; knowing that numbers in a counting sequence refer to specific quantities and that higher numbers reflect greater quantities) (Griffin, 2004), and more general factors sometimes characterised as "working memory" (Raghubar, Barnes, & Hecht, 2010). Reid (2008) showed that an early informal understanding of quantitative relationships provides the basis for developing formal mathematical knowledge.

Thomson, Rowe, Underwood, and Peck (2005) followed the development of numeracy in a sample of Australian children from preschool to the first year of school. Their study highlighted children's diverse preschool experiences and showed that there was a wide range in early numeracy achievement across the sites that were examined.

But numeracy is more than just numbers and measurements. Research has shown that young people's numeracy skills are a vital foundation for their subsequent achievements through school and into further education, training and work (e.g., Aubrey, Godfrey, & Dahl, 2006; Doig & de Lemos, 2000; Stevenson & Stigler, 1992; Young-Loveridge, Peters, & Carr, 1997). Therefore, one of the major objectives in educational policy is to provide children with strong numeracy skills through the years of schooling.

To enrich the understanding of the factors that lead to better educational outcomes, a number of national and international assessment surveys take place worldwide. These include the Organisation for Economic Co-operation and Development (OECD) Programme for International Student Assessment (PISA), the Trends in International Mathematics and Science Studies (TIMSS), and the Australian National Assessment Program—Literacy and Numeracy (NAPLAN) (Australian Curriculum Assessment and Reporting Authority [ACARA], 2010b). Recent results from the OECD PISA reveal that, while 15-year-old Australian students are still performing well above the OECD average (OECD, 2010), their results in numeracy have declined significantly over recent years. Significant gaps in achievement are also observed between students from different socio-economic backgrounds.

This chapter uses data from the K cohort of *Growing Up in Australia*: The Longitudinal Study of Australian Children (LSAC) to examine the numeracy skills demonstrated by children at different ages, and whether levels of numeracy skills vary for children from different socio-demographic backgrounds. The socio-demographic groups examined in this chapter are categorised by:

- child gender;
- socio-economic characteristics:
  - family socio-economic position (SEP)—lowest 25%, middle 50%, highest 25%; and

- mother's working hours—not working (including those unemployed, on maternity leave, and not in the labour force), working less than 35 hours per week, or working 35 hours or more per week; and

- family characteristics:
  - family type—two-parent family, lone-mother family; and
  - number of siblings in the household—no siblings, one or two siblings, three or more siblings.

See Chapter 1 for details about these groups.

8.1 Measuring numeracy in LSAC

In LSAC, information on the child's numeracy skills is obtained from two different sources:

- teachers' ratings; and
- NAPLAN results.

A list of numeracy measures used in Waves 1–3 is presented in Table 8.1.

Table 8.1 Numeracy assessments, K cohort Waves 1–3

Time point	Average age (SD = 3 months)	Instrument	Respondent/ informant	No. of observations [a]
Wave 1, 2004	4 years, 9 months	Teachers' ratings	Teacher [b]	3,176
Wave 2, 2006	6 years, 10 months	Teachers' ratings: Academic Rating Scale, Numeracy Skills sub-scale, 6–7 years	Teacher [b]	3,505
Wave 3, 2008	8 years, 10 months	Teachers' ratings: Academic Rating Scale, Numeracy Skills sub-scale, 8–9 years	Teacher [b]	3,533
2008/09	8 years, 7 months	NAPLAN: Numeracy test, Year 3 [c]	Study child	2,514

Notes: [a] The number of observations is determined by availability of the data. [b] Teachers' ratings were provided by the teacher who had primary responsibility for the planning and delivery of the group program in which the study child participated. [c] K cohort children sat the Year 3 NAPLAN Numeracy test in 2008 or 2009, depending on the year of their enrolment. Those children (n = 770) who sat the Year 5 NAPLAN Numeracy test in 2009 are not included in this chapter.

Teachers' ratings

Teachers' ratings were collected using the LSAC teacher questionnaire, in which teachers were asked to judge the proficiency of the child's numeracy skills in relation to other children the same age. The items in the teachers' ratings covered different areas of numeracy, such as number, measurement and space, and differed across waves to reflect different levels of difficulty.

In Wave 1, teachers were asked to rate the child's numeracy skills compared to other children of a similar age, using a yes/no scale of five items (see Table 8.2 for a list of items). The total numeracy score was calculated as the number of yes responses; the higher the score, the more numeracy skills a child had acquired.

Table 8.2 Teachers' ratings scale, K cohort Wave 1

Item	Abbreviation
1 Able to sort and classify objects by shape or colour	Sort and classify
2 Able to count the number of a few objects accurately	Count objects
3 Able to count to 20	Count to 20
4 Able to recognise numbers	Recognise numbers
5 Able to do simple addition with concrete materials	Simple addition

In Waves 2 and 3, teachers' ratings of the children's numeracy skills were obtained using the Numeracy Skills sub-scale of the Academic Rating Scale (ARS) for 6–7 year olds and 8–9 year olds, respectively. These scales were adapted for use in Australian schools by Rothman (2009). Tables 8.3 and 8.4 (on page 81) present the scale items used for different ages. Teachers were asked to rate a child's proficiency on each item using a five-point ordinal scale (1 = not yet, 2 = beginning, 3 = in progress, 4 = intermediate, 5 = proficient). The overall measure of numeracy achievement was calculated using the Rasch rating score model, and higher scores indicate more advanced levels of numeracy achievement. It is worth noting that teachers' ratings in Wave 1 and the ARS in Waves 2–3 are relative measures because at each wave, different teachers rate the child's performance in relation to different children of the same age. Although the ARS for mathematical thinking is a reliable measure in the sense that scores on the similar items are related (internally consistent), it is not designed to compare children's numeracy skills at different points in time (National Center for Education Statistics [NCES], 2004).

Table 8.3 Academic Rating Scale, Numeracy Skills sub-scale at 6–7 years, K cohort Wave 2

Item		Abbreviation
1	Can continue a pattern using three items	Pattern
2	Demonstrates an understanding of place value (e.g., by explaining that 14 is 10 plus 4, or using two stacks of 10 and 5 single cubes to represent the number 25)	Place value
3	Models, reads, writes and compares whole numbers (e.g., recognising that 30 is the same quantity if it is 30 rabbits or 30 tallies or 15 + 15 red dots, or describing that the number 25 is smaller than 41)	Whole numbers
4	Counts change with two different types of coins (e.g., one dollar and two 20¢ pieces, or a 50¢ piece and three 10¢ pieces)	Count coins
5	Surveys, collects and organises data into simple graphs (e.g., making tally marks to represent the number of boys and girls in the classroom)	Graphs
6	Makes reasonable estimates of quantities (e.g., looking at a group of objects and deciding if there is more than 10, about 50, or less than 100)	Estimates
7	Measures to the nearest whole number using common instruments (e.g., rulers, tape measures, thermometers or scales)	Measurements
8	Uses a variety of strategies to solve maths problems (e.g., using manipulative materials, using trial and error, making an organised list or table, or looking for a pattern)	Strategies

Source: © NCES. Scales adapted for use in Australian schools (Rothman, 2003).

Table 8.4 Academic Rating Scale, Numeracy Skills sub-scale at 8–9 years, K cohort Wave 3

Item		Abbreviation
1	Creates and extends patterns (e.g., can extend an alternating pattern involving addition, or can create a complex visual pattern)	Patterns
2	Uses a variety of strategies to solve maths problems (e.g., adds 100 and subtracts 2 when doing the mental math problem 467 + 98)	Strategies
3	Recognises properties of shapes, and relationships among shapes (e.g., recognises that rectangles can be seen as being composed of two right triangles, or demonstrates congruence by copying the exact size and shape of a pentagon onto a geoboard)	Shapes
4	Uses measuring tools accurately (e.g., measures with rulers in centimetres, or measures liquids to the nearest litre)	Measurement
5	Shows understanding of place value with whole numbers (e.g., correctly orders 9,321, 4,999, 900 and 9,101 from least to greatest)	Place value
6	Makes reasonable estimates of quantities and checks answers (e.g., estimates the cost of a list of 8 different items and compares them to actual cost, or estimates the perimeter of a room and then checks with a metre stick)	Estimates
7	Surveys, collects and organises data into simple graphs (e.g., charts temperature changes over time, or makes a bar graph comparing the population in different cities in Australia)	Graphs
8	Models, reads, writes and compares fractions (e.g., understands and shows that ½ of the chocolate bar is ¼ + ¼)	Fractions
9	Divides a two-digit number by a one-digit number (e.g., 78 ÷ 2 or 36 ÷ 4)	Division

Source: © NCES. Scales adapted for use in Australian schools (Rothman, 2003).

NAPLAN results

NAPLAN is a nationally administered test designed to assess the achievements of students in Years 3, 5, 7 and 9 in reading, writing, language conventions (spelling, grammar and punctuation) and numeracy. The test has been conducted since 2008 at the same time each year.

The NAPLAN Numeracy test measures the achievement of students in five broad areas of numeracy—number; algebra, function and pattern; measurement, chance and data; space; and working mathematically—as defined by the *Statements of Learning for Mathematics* (MCEECDYA, 2008). The test contains multiple-choice items and constructed response items. The Numeracy Skills sub-scale has scaled scores that are grouped into 10 bands. Bands correspond to the complexity of skills being assessed; that is, test items are more complex in higher bands. Band 2 refers to the National Minimum Standards (NMS) for children in Year 3. Year 3 children who score in Band 1 are performing below the NMS, and Year 3 children who score in Band 3 and above demonstrate academic performance above the NMS for Year 3.

In this chapter, we use only the results from the Year 3 NAPLAN Numeracy test, which took place in 2008 and in 2009.

8.2 Teachers' ratings of numeracy

Numeracy in kindergarten years (4–5 years old)

Figure 8.1 shows the proportion of children who had developed particular numeracy skills (able) and who had not (not able). About 95% of children in the K cohort at Wave 1 (whose average age was 4 years and 9 months) could sort and classify objects by shape and colour as well as count the number of a few objects accurately. Seventy-two per cent of children were able to recognise numbers and 62% of children were able to count to 20. Thirty-four per cent of children were able to do simple addition with concrete materials.

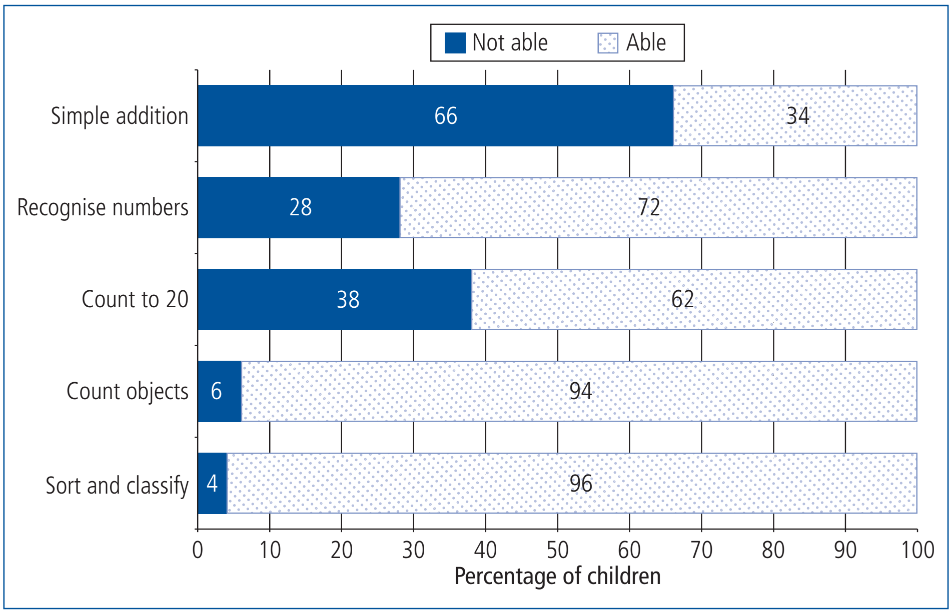


Figure 8.1 Percentage of children who developed particular numeracy skills, by teachers' ratings, K cohort Wave 1

Numeracy in early primary years (6–7 years old)

Figure 8.2 (on page 83) shows the proportion of children at different levels of proficiency on each item of the Numeracy Skills sub-scale of the Academic Rating Scale for 6–7 year olds. The degree to which the children had acquired the competencies is reflected by different categories. Children who did not demonstrate the skill are represented by the "not yet" category. The "beginning" category represents the proportion of children who were just beginning to demonstrate the skill. The proportion of children who demonstrated the skill with some regularity is represented by the third category, "in progress". The "intermediate" category represents the proportion of children who demonstrated the skill with average competence. The last category, "proficient", represents children who demonstrated the skill competently and consistently.

The average age of the K cohort children at Wave 2 was 6 years and 10 months. Most of these were able to continue a pattern using three items; that is, 93% of these children achieved a proficient (52%), intermediate (28%) or in progress (13%) level of competency. Six per cent of the children were just beginning to demonstrate the skill and only 1% of them were not yet able to continue a pattern.

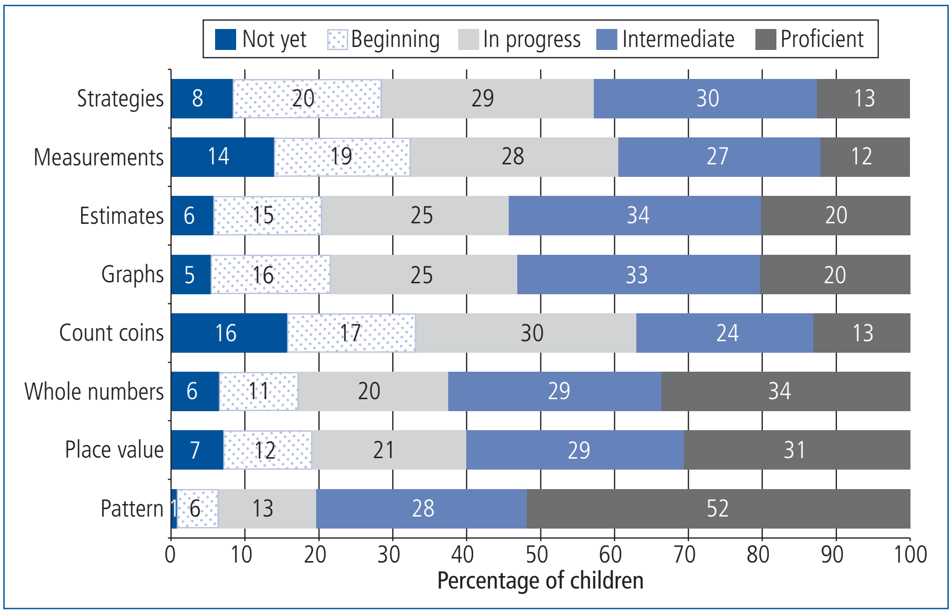
More than 80% of the children were able to understand place value. Of these, 31% of children were able to understand place value competently and consistently and 50% were able to apply this skill with average competence (intermediate = 29%) or regularly (in progress = 21%). Around one-fifth either used it very rarely (12%) or had not yet developed this skill (7%) .

Most of the children were able to manipulate whole numbers, with every third child being proficient (34%) and every second child applying this skill either with average competence (intermediate = 29%) or regularly (in progress = 20%). One in six of the children either were just beginning to apply this skill (11%) or did not demonstrate this skill (6%).

About 80% of the children were able to make reasonable estimates of quantities and represent data using graphs, with 20% of them being able to do it proficiently and about 60% being able to do it at intermediate or in-progress levels. Fifteen per cent of children tried to make reasonable estimates (beginning) and 16% of children attempted to use graphs (beginning). Only 3–6% of the children had not yet developed these skills.

About 70% of children were able to use strategies to solve mathematical problems, count change using different coins and make measurements, with about 13% of them being proficient and 54–59% achieving either at intermediate or in-progress levels. Out of the whole sample, 16% of children could not calculate change, 14% were not able to use measurement instruments and 8% did not use different strategies to solve mathematical problems.

Overall, around 50% of children were achieving at intermediate or in-progress levels on all the skill items, with the variation in proportions mainly observed at the extreme ends of achievement.



Notes: Percentages may not total exactly 100% due to rounding.

Figure 8.2 Percentage of children who achieved each level of competency of the ARS Numeracy Skills sub-scale for 6–7 year olds, K cohort Wave 2

Numeracy in middle primary years (8–9 years old)

Figure 8.3 (on page 84) shows the different levels of proficiency achieved on each item of the Numeracy Skills sub-scale of the ARS for 8–9 year olds. As above, the degree to which the children had acquired the competencies is reflected by different categories, ranging from not yet to proficient.

The K cohort children had an average age of 8 years and 10 months at Wave 2. About 90% of these children were able to continue a complex pattern, with 35% being proficient and 54% of them achieving at intermediate or in-progress levels. At this age, 8% had just started to demonstrate this skill and only 3% of the children could not continue a complex pattern.

More than 80% of the children were able to use a variety of strategies to solve mathematical problems, with 24% of them being proficient and around 60% achieving either at intermediate or in-progress levels. While every eighth child was achieving at a beginner level (12%), 7% of them were not yet able to use strategies to solve mathematical problems.

Most of the children were relatively advanced in manipulating shapes and using measurement instruments, with about 25% being proficient, and more than 60% being able to use these skills with average competence or regularly. Eleven per cent were starting to demonstrate some familiarity with these skills, while 4% of the children were not yet able to manipulate shapes and 2% were not yet able to use measuring tools accurately.

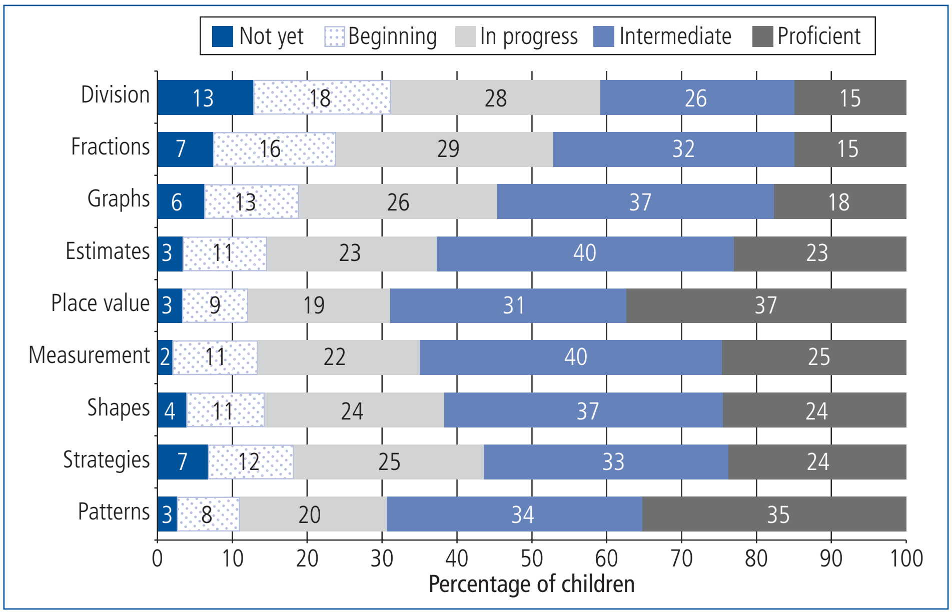
At this age, more than 80% of the children were capable of using graphs and estimating quantities, with 23% being proficient in estimates and 18% being proficient in graphs. Eleven per cent of the children had just started to demonstrate their understanding of estimates and only 3% did not demonstrate this skill at all. Thirteen per cent were just beginning to manipulate graphs and 6% did not know how to work with them at all.

With regard to understanding and using place value, 37% of the children were proficient and 50% had an intermediate or in-progress level of competence. Nine per cent of children had just started to develop this skill and only 3% of children did not understand place value.

The least developed skills were the ability to understand fractions and to perform division. Every third child either was not able to perform division at all (13%) or was just beginning to grasp the skill (18%). Every fourth child either did not understand fractions at all (7%) or had just started to develop an understanding (16%). Between 54% and 61% of the children were rated as achieving either intermediate or in-progress levels. Every seventh child (15%) was achieving at a proficient level.

As in Wave 2, more than 60% of children in Wave 3 were achieving at intermediate and in-progress levels overall, with the largest variation in proportions being observed at the ends of the distribution.

These data based on items from the ARS can be used to provide information about the emergence and development of particular aspects of numeracy in the early and middle primary years.



Notes: Percentages may not total exactly 100% due to rounding.

Figure 8.3 Percentage of children who achieved each level of competency of the ARS Numeracy Skills sub-scale for 8–9 year olds, K cohort Wave 3

8.3 NAPLAN Numeracy test Year 3 results

Table 8.5 shows NAPLAN Numeracy test results for children in the K cohort who sat Year 3 NAPLAN tests in 2008 or 2009. There were 2,381 children who sat the NAPLAN test in 2008 and 142 children who sat the test in 2009—a total of 2,523 children. The children's average age was 8 years and 7 months.

Ninety per cent of these children performed above the National Minimum Standards (Band 3 and above). Only 2% of children performed below the NMS (Band 1) and 8% of children performed at the NMS (Band 2). The average mean score was within Band 5. Nine out of the 2,523 children were exempted from the test.

Table 8.5 Performance against the National Minimum Standards (NMS) for numeracy, NAPLAN, K cohort Wave 3, 2008–09

Below NMS (%)	At NMS (%)	Above NMS (%)				Exempt (%)	Total no. of children	Mean test score (*SD*)
Band 1	Band 2	Band 3	Band 4	Band 5	Band 6+			
1.9 (*n* = 48)	7.6 (*n* = 192)	17.0 (*n* = 429)	25.9 (*n* = 654)	25.4 (*n* = 640)	21.8 (*n* = 551)	0.4 (*n* = 9)	2,523	427.0 (2.7) (*n* = 2,514)

As described by ACARA (2010b), a student assessed to be meeting the NMS at Year 3 (Band 2) would be expected to be able to: double a whole number to solve a simple problem, recognise a two-dimensional shape within a pattern of different shapes, visually compare the area of similar shapes, and locate a position of an object on a simple plan. A student assessed to be just above the NMS (Band 3) would be expected to be able to: use repeated addition or simple multiplication to solve simple problems, interpret a timetable and locate information, select the most likely outcome in a simple chance event, recognise geometric properties of two-dimensional shapes, and use a grid to identify a symmetrical drawing. The largest proportion of students had performances located in Bands 4 and 5. A student assessed to be in Band 4 would be expected to be able to: use addition and subtraction of two-digit numbers to solve problems, continue number patterns, recognise and use simple fractions to solve problems, identify a prism displayed in an everyday context, estimate the volume of liquid in a familiar container, and visualise a three-dimensional model from a different perspective. A student assessed to be in Band 5 would be expected to be able to: apply a small range of strategies to solve problems, match a digital time to a given analogue time, identify a quarter-turn rotation of a two-dimensional shape, interpret directions to identify a location on a simple map, and interpret a number line to find the number halfway between two three-digit numbers.

8.4 Analysis by socio-demographic characteristics

This section examines the relationships between children's levels of proficiency in numeracy and key demographic and family characteristics, using subpopulation groups characterised by:

- child gender;
- socio-economic characteristics:
  - family socio-economic position—lowest 25%, middle 50%, highest 25%; and
  - mother's working hours—not working (including those unemployed, on maternity leave, and not in the labour force), working less than 35 hours per week, or working 35 hours or more per week; and
- family characteristics:
  - family type—two-parent family, lone mother family; and
  - number of siblings in the household—no siblings, one or two siblings, three or more siblings.

These descriptors were chosen as factors that were likely to be associated with numeracy outcomes for children (Battle & Lewis, 2002; Casey, Nuttall, & Pezaris, 2001; Downey, 1995; Fennema, Sowder, & Carpenter, 1999; Goldberg & Prause, 2010; Horwood & Ferguson, 1999; Matthews, Ponitz, & Morrison, 2009; Pong, Dronkers, & Hampden-Thompson, 2003; Shavit & Pierce, 1991). Another factor likely to be related to numeracy outcomes is the level of parental education; however, this was omitted, as parental education was used to derive the measure of family socio-economic position. The subpopulation groups were examined in relation to overall numeracy scores, as measured using different teachers' ratings instruments and results on the NAPLAN Numeracy test.

Table 8.6 presents mean numeracy scores by subpopulation groups at different time points. The difference between means within each subpopulation is considered statistically significant if the corresponding confidence intervals do not overlap.

Table 8.6 Mean numeracy scores, by subpopulation groups, K cohort Waves 1–3

		Teachers' ratings			NAPLAN Numeracy test
		Wave 1	Wave 2	Wave 3	Year 3, 2008/09
Overall scores	Mean (SE)	3.6 (0.03)	3.4 (0.02)	3.5 (0.02)	427.0 (2.70)
	N	3,176	3,505	3,533	2,514
Child gender					
Male	Mean (SE)	3.5 [a] (0.03)	3.4 (0.02)	3.5 (0.03)	419.2 (2.7)
	N	1,616	1,769	1,819	1,338
Female	Mean (SE)	3.7 [a] (0.03)	3.4 (0.02)	3.4 (0.02)	412.8 (2.4)
	N	1,560	1,764	1,686	1,176
Socio-economic position					
Low (25%)	Mean (SE)	3.1 [a] (0.05)	3.1 [a] (0.03)	3.2 [a] (0.03)	391.6 [a] (3.1)
	N	714	841	839	584
Middle (50%)	Mean (SE)	3.6 [a] (0.03)	3.4 [a] (0.02)	3.5 [a] (0.02)	413.9 [a] (2.2)
	N	1,599	1,787	1,753	1,228
High (25%)	Mean (SE)	4.0 [a] (0.04)	3.7 [a] (0.03)	3.8 [a] (0.03)	453.3 [a] (3.0)
	N	856	903	909	701
Mother's working hours					
Not working	Mean (SE)	3.5 [a] (0.03)	3.3 [a] (0.03)	3.4 [a] (0.03)	414.2 (2.9)
	N	1,423	1,358	1,056	735
Less than 35 hours per week	Mean (SE)	3.7 [a] (0.03)	3.4 [a] (0.02)	3.5 [a] (0.02)	420.8 (2.4)
	N	1,310	1,531	1,649	1,222
35 hours or more per week	Mean (SE)	3.7 (0.06)	3.4 (0.03)	3.5 (0.03)	409.6 (3.9)
	N	432	644	800	557
Family type					
Two-parent family	Mean (SE)	3.7 [a] (0.02)	3.4 [a] (0.02)	3.5 [a] (0.02)	420.2 [a] (2.0)
	N	2,777	3,019	3,037	2,173
Lone-mother family	Mean (SE)	3.2 [a] (0.07)	3.2 [a] (0.04)	3.2 [a] (0.05)	396.0 [a] (4.0)
	N	384	486	438	319
Number of siblings in the household					
No siblings	Mean (SE)	3.5 (0.07)	3.3 (0.05)	3.4 (0.06)	412.9 (5.8)
	N	337	311	274	205
1 or 2 siblings	Mean (SE)	3.7 [a] (0.02)	3.4 [a] (0.02)	3.5 [a] (0.02)	420.0 [a] (2.1)
	N	2,453	2,705	2,690	1,912
3 or more siblings	Mean (SE)	3.3 [a] (0.06)	3.3 [a] (0.04)	3.3 [a] (0.04)	401.9 [a] (3.7)
	N	386	517	541	397

Note: The "a–a" superscript pairs denote significant differences between means within subpopulation group comparisons, as determined by non-overlap of their respective 95% confidence intervals. For example, in Wave 1, the mean numeracy score for the low SEP group was significantly different from mean numeracy score for the middle and high SEP groups; the middle SEP group was also significantly different from the high and low SEP groups. The number of observations for some groups may not add up to the total number of observations due to non-response.

Child gender

Among K cohort children at Wave 1, girls tended to have more developed numeracy skills than boys (and this difference was significant). As the children grew older, boys had slightly higher numeracy scores than girls; however, these differences were not statistically significant.

Socio-economic characteristics

There were significant differences in numeracy achievement according to family socio-economic position. Children from families with a lower socio-economic position had significantly lower scores than children from higher socio-economic backgrounds. This difference remained statistically significant at different ages and across different numeracy measures.

Children's progress in numeracy was also associated with their mother's working hours. According to teachers' ratings, children with mothers working either less than 35 hours or 35 or more hours per week scored higher than children with non-working mothers. But the difference in scores was statistically significant only between children whose mothers worked 0 hours and who worked less than 35 hours per week. These differences were consistent at all three time points. In contrast, analyses of the NAPLAN test results did not reveal any significant differences in numeracy achievement according to mother's working hours.

Family characteristics

A relationship between other family characteristics and numeracy achievement was also evident. Compared to children from two-parent families, children from lone-mother families had significantly lower numeracy scores for every numeracy measure at all ages.

The number of siblings in the household was also associated with level of numeracy achievement. While there was no statistically significant difference in numeracy progress between children with or without siblings, children with three or more siblings had significantly lower numeracy scores compared with children who had only one or two siblings. This relationship was consistent for every numeracy measure. It is important to note that these associations could reflect other correlated influences, such as that of lower socio-economic position (Downey, 1995; Shavit & Pierce, 1991). Multivariate analyses, which go beyond the scope of this chapter, would be required to explore these possibilities.

In addition to these results, it was found that children's language background (English- or non–English speaking) was not associated with their level of numeracy achievement (data not shown). It was also found that while the children of mothers under 25 years old received lower teachers' ratings compared with the children of older mothers, these differences disappeared after controlling for family socio-economic characteristics (data not shown).

Sub-group analyses in perspective

The results of the sub-group analyses for child gender do not reveal significant numeracy differences between boys and girls. National results reported for NAPLAN show a similar-sized difference of five scale points (the standard deviation is approximately 72 points) in favour of males for Year 3 students (ACARA, 2010a). Results for Year 4 students in the TIMSS show a similar difference of six scale points (the standard deviation is approximately 100 scale points) between boys and girls in Australia—a difference that is not statistically significant (Thomson, Wernert, Underwood, & Nicholas, 2008). The results for Year 4 in TIMSS indicate inter-country differences in the mathematics achievement of boys and girls, with boys scoring higher than girls in countries such as the United States, Sweden and Germany, but girls scoring higher than boys in countries such as Singapore and the Russian Federation. NAPLAN Numeracy test scores show wider numeracy gaps between boys and girls in Australia, with gaps of 10 to 12 scale points in Years 5, 7 and 9 in favour of boys (ACARA, 2010a). Similarly, TIMSS results for mathematics in Year 8 show a statistically significant gap of 15 points in favour of boys. However, this difference in favour of boys is not evident in all, or even a majority, of the TIMSS countries (Thomson, et al., 2008).

Associations with socio-economic position (or socio-economic status) appear to be broadly similar to those derived from these other studies, though it is not possible to compare these relationships directly because the measures are not equivalent. In NAPLAN, the Year 3 numeracy scores for children whose parents were senior managers and professionals were 55 points higher (on a metric where the standard deviation was 72 points) than those for children whose parents were in unskilled manual, office and sales occupations. Children who had at least one parent who was a university graduate had scores 73 points higher than those whose parents had attained Year 11 or less at school (ACARA, 2010a). TIMSS does not report differences by parental occupation or education for Year 4 children, but it does report differences according to the estimated number of books in the home. In Australia, Year 4 students from homes with more than 100 books had substantially higher average mathematics scores (a difference of 59 scale points) than those from homes with 25 or fewer books (Thomson, et al., 2008). This relationship was true for Australian Year 4 students, as well as, on average, across the participating countries. The TIMSS results for Year 8 students showed an even stronger relationship between mathematics scores and the number of books in the home, with the corresponding difference being around 80 points. In addition, those Year 8 data showed a gap of 74 points between Australian children who had a parent who was a university graduate and children whose parents had not completed upper secondary education (on a scale with a standard deviation of approximately 100 points) (Thomson et al., 2008). Similar associations between measures of socio-economic background and mathematical literacy (a somewhat different concept to numeracy) are evident in results from the OECD PISA (Thomson, De Bortoli, Nicholas, Hillman, & Buckley, 2010).

8.5 Summary

This chapter has provided an overview of the LSAC children's achievements in numeracy at different ages, as assessed by teachers' ratings and the children's performance on the NAPLAN Numeracy test. Overall, children had well-developed numeracy skills. At 4–5 years, most children were able to recognise numbers, count objects and count to 20, and classify and sort objects. At this age, one in three children were not able to do simple addition. At 6–7 years old, more than 70% of children were able to continue a pattern, understand place value, manipulate whole numbers, use graphs, make reasonable estimates, and use different mathematical strategies. The least developed skills at this age were calculating change using different types of coins and measuring to the whole number using common instruments. At 8–9 years, most children were able to create and extend a pattern using multiple rules, manipulate different shapes, use measurement tools accurately, check their answers, and organise data into graphs. At this age, the most difficult skills to develop were manipulation with fractions and division.

The level of proficiency varied according to socio-economic position and family characteristics. Children from lower socio-economic backgrounds tended to perform at a lower level compared to those from higher socio-economic backgrounds. Children living in lone-mother families or families with three or more siblings had lower numeracy scores, on average, than did children who were living with two parents or who had one or two siblings, respectively. It is worth noting that patterns of differences in NAPLAN results were consistent with teachers' ratings in terms of differences between groups.

While the analysis presented in this chapter is descriptive, the results provide support for intergenerational mobility policies, which aim to improve the opportunities for children from disadvantaged backgrounds. The results also emphasise the importance of undertaking further research on the relationships between children's backgrounds and their development, using both teachers' ratings of their attainment of aspects of numeracy and measures of numeracy based on the standardised assessments contained in NAPLAN.

8.6 Further reading

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