

Third edition

2015 OUP

Special Educational Needs, Inclusion and Diversity

Norah Frederickson and Tony Cline

Partnership with parents should not always involve a one-way traffic in which professionals provide support (Hughes *et al.* 2007). Many parents are the fount of hard-won wisdom on how to bridge the gap. Teachers will have much to learn from them, especially when the two groups come from different cultural backgrounds. 'Careful listening is the most critical aspect for anyone working with parents' (Wheale 2000: 2). Particular care may be needed when preparing 'Parent Information Sheets' about maths for families whose children have learning difficulties in the subject and require understanding and support (Hannell 2005).

Learning difficulties in mathematics

Within the school curriculum learning maths is uniquely challenging in that it is highly organized, sequential and progressive. Simpler elements must be learned successfully before moving on to others: 'It is a subject where one learns the parts; the parts build on each other to make a whole; knowing the whole enables one to reflect with more understanding on the parts, which in turn strengthens the whole. Knowing the whole also enables an understanding of the sequences and interactions of the parts and the way they support each other so that the getting there clarifies the stages of the journey' (Chinn & Ashcroft 1998: 4). Because of the interrelating nature of the subject, children who have learning difficulties in maths may sometimes appear to feel even more lost and disempowered than those who encounter problems in other subjects.

In this chapter learning difficulties in maths will be analysed first in terms of what children need to know and understand about maths and second in terms of the emotional significance that the subject has for many children and adults. We will then examine the language that is used in maths and the challenges it poses for many learners. Finally, there will be short accounts of specific learning difficulties in maths (a complex topic that has received less attention than specific learning difficulties in reading), and of the learning difficulties in maths that are associated with other SEN.

Mathematical knowledge and understanding

A full mastery of mathematics involves three major forms of knowledge:

- factual knowledge (e.g. having basic facts at one's finger tips such as number bonds and multiplication tables);
- procedural knowledge (e.g. knowing how to carry out particular written or mental calculations);
- conceptual knowledge (e.g. understanding the multiplicative relationship between the length and width of a rectangle and its area).

Fashions in the teaching of maths have shifted over time between emphasizing procedures and emphasizing concepts (Brown 1999). There is now, though, an international consensus among maths educators that 'the development of quick recall, accuracy and fluency in parallel with the development of understanding and reasoning are all

required to promote sound mathematical development.” (DfE 2011e: 67) In spite of a residual nostalgia among some politicians for a curriculum that would prioritize rote learning of mathematical facts (Ward 2012), research findings unequivocally support the broader view (e.g. Cowan *et al.* 2011).

While children’s understanding of mathematical concepts is positively correlated with their ability to execute procedures and their mastery of basic factual knowledge, it is commonly found that those who fall behind in maths across the board show in their early years a particular weakness in processes that are normally automatic. Examples of mathematical processes implicated in this are:

- *Approximate number precision*, the ability to estimate quantities of dots that are shown on screen for a very brief period (Libertus *et al.* 2013).
- *Number sense*, including counting knowledge and principles, number recognition and basic number comparisons (Jordan *et al.* 2010).

There are also underlying cognitive processes that appear to be crucial to maths learning so that indicators of difficulty in these areas are associated with poor progress in school maths. They include spatial skills and executive functions such as planning skills (Verdine *et al.* 2014) and working memory (Friso-van den Bos *et al.* 2013). Each of these elements will be highlighted below when learning difficulties in mathematics are discussed in more detail.

Anxiety and motivation

Many children and adults who take other intellectual challenges in their stride panic about maths. Buxton (1981) quoted adults saying things like ‘A string of figures and my brain seizes up’ and ‘I can’t think precisely enough for this sort of thing’. A survey carried out for the Cockcroft Committee (DES 1982) showed that such feelings were widespread in the adult population and that they were not without justification: many of those interviewed showed serious gaps in their competence when faced with mathematical problems in everyday life. Their performance will be worse if they feel anxious about it. The sense of helplessness could paralyse what capacity they have, and their approach to the task will be poorly planned and organized – the opposite of what is required to solve a mathematical problem. That will then lead to negative attitudes toward any tasks that require the management of numbers. In Activity 14.2 you will read what a university tutor in England thought the implications of such attitudes might be.

Activity 14.2 “Maths phobia”

The following extract from a website for university students aims to outline what a fear of maths might mean in the everyday life of an adult:

The fear of maths may not seem as scary as a fear of snakes or tarantulas; but think about it: when was the last time you encountered a snake in the checkout

queue at the supermarket, on your phone bill, or in your homework (biologists excepted from the latter). People who fear maths have to deal with that fear on a daily basis. Clearly it can be a major problem, and can seriously affect people's lives. Maths phobia affects people's lives by making them:

- lose confidence in themselves and in their academic abilities
- trust blindly any bills they receive, because they daren't question the figures
- shy away from helping their kids with their homework
- avoid courses in case they contain maths
- leave courses when they encounter the maths element
- run up credit card bills as they can't keep track of how much they've spent

Retrieved on 18/3/15 from the University of Hull Study Advice website

Reflect on how a fear of maths might affect a school child. What aspects of mathematics do you think would have the greatest impact in terms of raising anxieties, and how would those anxieties affect children's learning across the curriculum and their lives outside school?

There are many factors in maths anxiety. It may include:

- Test anxiety – fear associated with preparing for or taking a maths test;
- Task anxiety – apprehension relating to the execution of numerical operations;
- Course anxiety – stress associated with studying in a maths class (Tariq 2013).

The first two of those components were confirmed when Wu *et al.* (2012) conducted a factor analysis of scores on a newly developed maths anxiety scale.

What leads to such attitudes? A recent study of identical and non-identical twins has suggested that there may be a genetic component so that some children are pre-disposed to develop the problem (Wang *et al.* 2014). The mechanism for that will be better understood once the neuropsychological processes associated with maths anxiety are identified. A start has been made on this through functional MRI studies that showed, for example, intense activity during a maths task in the right amygdala regions of the brain in children with maths anxiety. This area of the brain is important for processing negative emotions. At the same time there was reduced activity in those prefrontal cortical regions that are thought to be involved in mathematical reasoning (Young, Wu & Menon 2012).

It seems likely that an important factor in the development of maths anxiety is exposure to negative experiences at school. Features of school experience that have been proposed as contributors to the outcome include traditional approaches to teaching the subject (Newstead 1998) and teachers' own anxieties about it (Beilock *et al.* 2010). As might be expected, maths anxiety has a negative impact on performance, possibly through disrupting the way in which working memory resources are applied to maths problems (Ashcraft 2002; Ramirez *et al.* 2013). With university

students there have been some efforts to reduce maths anxiety through individual therapy such as systematic desensitization (Zettle 2003). Similar initiatives have had some success in addressing school pupils' test anxiety through biofeedback and behaviour therapy (von der Embse *et al.* 2013). However, for maths anxiety the main thrust of intervention at school level has been to reduce the supposedly adverse factors in how the subject is taught, minimizing stress and fostering a positive mindset that would lead to "mathematical resilience". Examples provided by the research team who used that term included:

- making less use of tasks that required feats of memory or repetitive exercises that were not fully understood;
- encouraging collaborative work in mathematics rather than having pupils struggle on their own;
- fostering understanding through active engagement with unfamiliar tasks such as asking a group to represent mathematical ideas using their own bodies (e.g. being asked to envision their shoulders and body as axes and to make straight line graphs using their arms) or making a mathematics trail around the school by spotting mathematical ideas in the buildings and writing out a trail for other groups to follow.

(Johnston-Wilder & Lee 2010; Lee & Johnston-Wilder 2013)

For a fuller account of these issues and of research on gender as a factor in maths anxiety see the chapter on mathematics learning in Cline, Gulliford & Birch (2015).

'Reading' mathematics

Some have argued that communication is at the core of the subject and that maths should be seen 'as a "language" in the same way that Italian is a language' (Rowland 1995: 54). But there are some important differences too. In everyday life many of the concepts we use most often are imprecise, contradictory and ambiguous. We tend to qualify what we say and put our thoughts forward tentatively. Mature adults like to express uncertainty and feel it is important to be able to tolerate ambiguity. When we talk, our comments are often repetitive, circular, imperfectly structured and full of redundancy. It is often claimed that mathematical thought is very different so that mathematical language is abstract, unambiguous, precise and without redundancies. This may be one reason why some people find the subject intimidating.

A specific source of difficulty in learning the language of maths is its reliance on special symbols. First, the speech forms used for "+", "-", etc. vary a great deal. Teachers have to decide when to employ one form consistently in order to aid understanding in their own classroom and when to vary the forms they use in order to aid generalization to other settings. Second, the same symbol may be used in ways that appear intuitively different. For example, the symbol 'x' causes integers such as 3 to increase (as in $2 \times 3 = \square$) but fractions such as three quarters to decrease (as in $2 \times \frac{3}{4} = \square$). Third, the abstract character of mathematical symbols creates difficulties for children who may understand a concept in context but not when contextual cues

are removed. Fourth, the organization of mathematical symbols in writing or print presents a challenge to children who are confused about left and right, or have problems over sequencing, or have visual-perceptual difficulties. For example, a child may read 34 as 43, or may tackle a decimal sum from the wrong direction, or may make frequent mistakes when reading down a column of figures.

Many of these problems arise because in a decimal system place value is crucial: the same digit (e.g. 3) means *three* if it appears in the right hand *units* column and *thirty* if it appears in the left hand *tens* column. Children in English-speaking countries often struggle to appreciate this (Jones & Thornton 1993). There is evidence that place value difficulties may be less acute for children in some other language communities, notably in Asia. Children appear to achieve higher standards of accuracy and speed in place value judgements in countries where the language reflects place value in a more systematic and consistent way than English (e.g. saying the equivalent of 'ten and four' instead of 'fourteen'). It has sometimes been suggested that this language based disadvantage may underlie the consistent reports of large national differences in maths achievement (e.g. Jerrim & Choi 2014). However, careful studies of the various cultural and pedagogic factors that might be involved have suggested that the language factor is of limited significance (e.g. Cheng & Chan 2005; Dowker *et al.* 2008).

Nonetheless the fundamental point remains valid: where the language of number is inconsistent in its structure, children are more likely to experience difficulties in learning to use it for maths and to transform it into its two written forms – number words and Arabic numerals. Thompson (2000) reported evidence that children are likely to find it easier to move between those two forms if they have a good deal of experience of decimal calculations through mental maths before they are required to set out the numbers in columns in their written form. He subsequently argued that the key aim should be to help children develop not just knowledge of place value but a broad grasp of how numbers work and what they mean, an "overall number sense" (Thompson 2003: 189).

Mathematicians' claims that the language of their subject is exact and concise appear to be undermined also by the ambiguous ways in which everyday terms are often used in maths education (see Table 14.4). It is words in the two right-hand columns that are reported to cause most confusion.

There is an additional dimension of linguistic complexity and ambiguity for bilingual children. In a report on a GCSE paper set in Wales, Jones (1993) analysed the effect of translating the general English word 'similar' (in a phrase about 'similar triangles') into a Welsh word, *cyflun*, which is used only in maths. In a sample of Welsh and English speakers who were matched for overall maths achievement, the Welsh speakers did almost twice as well as the English speakers on that item. William (1994) showed how the technical and non-technical uses of terms for 'speed' and 'velocity' in the two languages could work in the opposite direction, making items more difficult in the Welsh version. Bilingual children will often struggle to deal with such translations but may, in an encouraging environment, explore the nuances of meaning that are involved. Issa and Eve (2009) reported on a classroom conversation in a London school in which an EAL learner whose first language

Table 14.4 Varieties of words used in the teaching of mathematics (Shuard & Rothery 1984, Ch. 3; Barnes 2009)

Words that have the same meaning in mathematical English as in everyday English	Words that have a meaning only in mathematical English	Words that have a similar but more precise meaning in mathematical English than in everyday English	Words that have different meanings in mathematical English and everyday English	Different mathematical words that mean the same thing
cat	hypotenuse	area	difference	subtract/take away
dog	parallelogram	divide	product	add/plus/and
because	coefficient	estimate	parallel	multiply/times
it	quotient	place	odd	sum/total/altogether
taxi	multiple	order	mean	
shelves		rule	value	
climb			prime	
			unit	
			table	
			times	
			sign	

was Turkish chose to use a Turkish phrase in a discussion about two sides of a square, explaining later: "I know I could have used the English word there but '*tipatip ayni*' [translated by the authors as literally 'identically same'] describes what I want to say best." (p. 3). A child needs to be confident both in their mastery of each language and in the mathematical reasoning that is required if they are to treat language differences as a stimulating opportunity rather than a discouraging challenge.

It is not just the vocabulary of maths that causes difficulty. The syntax in which mathematical ideas are expressed is often more complex than children are accustomed to in other areas of the curriculum. This may present particular challenges to pupils who are learning EAL. Examples include the use of the passive voice (as in 'Each side of the equation is divided by 3') and describing relationships (as in 'as the height increases, the weight increases in proportion'). Elbers and de Haan (2005) showed that, when collaborative learning was encouraged in a multicultural primary school classroom in the Netherlands, pupils' discussions of unfamiliar vocabulary became part of their exploration of the mathematical tasks and they solved language problems through their growing knowledge of the mathematical discourse. The impact of a similar initiative involving collaborative learning approaches in England is described by Symonds (2010).

Sometimes, however, the content of what is intended to be a down-to-earth, everyday problem is itself the source of difficulty for some pupils. For example, Virani-Roper (2000: 70) tells the story of a Ugandan boy who could not solve a simple word problem that required a calculation involving fractions, not because he did not understand the fractions but because he had no knowledge of the fruit that was the subject of the question. He was asked: "I ate half an apple and half of what was left. What was left?" As an answer he wrote down "seeds". When the teacher asked what would happen if she had an orange instead, the boy's reply was to ask what an apple is. This fruit did not then grow in Uganda. If teachers attempt to contextualize mathematical ideas with examples that are outside the experience of some pupils they make the mathematics more difficult rather than more transparent (Barwell 2005). Visual illustrations of a word problem can be helpful but only if they convey relevant information in a clear manner that helps readers to recognize the essential elements of the problem (Berends & Lieshout 2009). These issues affect monolingual children as well as those learning EAL. Jordan *et al.* (2003) have shown that the linguistic challenges of mathematical problem solving may lead to underperformance by children from low income families, even if their first language is the language of school instruction.

Specific learning difficulties

Various terms are used for specific learning difficulties in mathematics, including dyscalculia, mathematics learning disability and arithmetic learning disability. In the same way that dyslexia is sometimes called 'developmental dyslexia', the diagnostic term for dyscalculia is sometimes expanded to emphasize that it is assumed to be a problem from birth and not acquired through injury or illness – *developmental dyscalculia* (DD). The fundamental tasks of mathematics that children with DD

may find challenging include understanding number concepts and the number system, counting, remembering basic arithmetic facts, estimating, and appreciating the mathematical processes required to solve a simple 'story' problem (Watson & Gable 2013). A strong case has been made that, underlying all this from an early developmental stage, the basic problem in DD is a failure to grasp *numerosity*:

Broadly, a child will understand the concept of numerosity if she or he:

- understands the one-to-one correspondence principle;
- understands that sets of things have numerosity and that some manipulations of these sets affect the numerosity – combining sets, taking subsets away, and so on – and that one set has the same numerosity as another, or a greater numerosity, or a smaller numerosity;
- understands that sets need not be of visible things; they can equally be audible things, tactile things, abstract things (like wishes);
- can recognize small numerosities – sets of up to about four objects – without verbal counting.”

(Butterworth 2005: 4)

Estimates of the prevalence of DD vary between 1.3 and 10 per cent of the child population depending on the breadth of the definition that is adopted (Devine *et al.* 2013). The criteria for DD that appear in the literature include:

- (1) criteria that are based on a discrepancy between IQ and maths achievement;
- (2) criteria that are based on performance on standardized maths tests;
- (3) criteria that are based on a measure of delay in achievement so that a child is categorized as having DD if their maths performance is equal to or below the average level of children two years younger;
- (4) criteria that are based on a version of response to intervention (see Chapter 6), e.g. showing resistance to maths interventions.

(Devine *et al.* 2013: 31–3)

Only the first criterion in that list excludes below average performance in another aspect of a child's functioning. With criteria (2)–(4) a child could be experiencing difficulties in other areas of development or learning. 'Comorbid' problems in areas such as reading are, in fact, common (Rubinsten 2009). In addition, the use of a discrepancy definition related to IQ has raised similar issues for those interested in DD as have caused controversy in relation to dyslexia (see Chapter 13). For example, it is not clear how maths learning difficulties differ if associated with high vs low measured intelligence (Geary 2011).

As we noted earlier, many different aspects of psychological functioning have been implicated in mathematics learning difficulties, including language difficulties, spatial difficulties and memory difficulties as well as specific problems in

processing numbers. It is likely that the contributions of different skills vary as a student progresses through the curriculum. This can be illustrated with the example of working memory. At every stage of development mathematical tasks require the use of a cognitive workspace to control and maintain the information that is needed for the task. Partial information will be retained while new information is processed and added, all of which makes demands on working memory resources. As children grow older, the counting procedures, reasoning and problem solving in which they are involved become more complex so that those demands on working memory will increase (Watson & Gable 2013). Visual-spatial memory always has a role in maths tasks, but a review of findings from longitudinal studies suggested that it makes a particularly significant contribution in early mathematical learning by younger children (Raghubar *et al.* 2010).

There have been a number of hypotheses about the underlying causes of DD. A recent overview by Andersson *et al.* (2012) included:

- (1) A deficit in basic cognitive functions such as working memory or long-term memory – a *domain general cognitive deficit*
- (2) A problem in the “approximate number system” (ANS) which represents large, approximate quantities – a *domain specific cognitive deficit*
- (3) A problem in the object tracking system (OTS) which represents up to four objects without counting (subitizing)
- (4) A defect in numerosity-coding (see Butterworth’s account that was quoted above)
- (5) A problem in appreciating the meaning of mathematical symbols even when the underlying concept is understood (e.g. of a magnitude of 2) – an *access deficit*
- (6) There may be multiple causes with one child struggling with the ANS, another with numerosities and so on – the *multiple deficit hypothesis*

Mathematics is a complex activity, and while some evidence has been found to support each of those hypotheses, it seems likely that individual children may encounter a range of different obstacles initially and may then present with a combination of particular difficulties (Cowan & Powell 2014). However, some children may present with consistent patterns of difficulty, and there is some research support for the validity of a set of distinctive “cognitive subtypes of mathematics learning difficulties”. For example, Bartelet *et al.* (2014) analysed correlations among test scores on a range of tests by children aged 6–10 and found six distinguishable clusters of difficulties that to a large extent echoed the list above. They suggested that it may be possible to tailor interventions to suit individuals within the different subtypes but acknowledged that the evidence base did not yet exist to show that children with particular subtypes respond differently to matched interventions.

The research underpinning those conclusions has generally involved the analysis of performance across a range of mathematical and cognitive tests. A number

of other authors have drawn quite different conclusions from two separate lines of research in neuroscience and genetics. Thus, for example, Butterworth *et al.* (2011) state firmly at the beginning of their review that “recent neurobehavioral and genetic research suggests that dyscalculia is a coherent syndrome that reflects a single core deficit. Although the literature is riddled with different terminologies, all seem to refer to the existence of a severe disability in learning arithmetic” (p. 1049). Their representation of how it may develop involves a model that is similar in format to the Interactive Factors Framework introduced in Chapter 5. Neurological development at the biological level impacts on how numerosity is represented and manipulated at the cognitive level and also on a child’s spatial abilities. These, in turn, affect cognitive processes such as arithmetic fact retrieval and the understanding of number symbols. All this can be inferred at the behavioural level from how a child tackles simple number tasks and other aspects of arithmetic. Like Bartelet *et al.* (2014), Butterworth *et al.* believe that their analysis lays the basis for new interventions that “promise effective evidence-based education for dyscalculic learners”, but in this case the expectation is that the aim will be “to strengthen numerosity processing” (p. 1049).

Learning difficulties in mathematics associated with other SEN

Children who have sensory or physical difficulties often experience related problems in maths. For example, children with DCD may have difficulties in analysing and organizing what they see in terms of visuo-spatial relationships (e.g. when estimating the dimensions of a two-dimensional figure on a page or trying to understand a three-dimensional figure) (Dixon & Addy 2004, Chapter 8). In addition, they may have difficulty in writing numbers accurately or may become confused because they are not able to set out two- or three-digit numbers neatly in the necessary columns. The nature of the challenge should not be exaggerated. Pieters *et al.* (2012) found a significant developmental delay when two groups of children with DCD in Belgium were compared with age-matched controls on tasks that involved mathematical number fact retrieval and procedural calculation. However, the performance profile was similar, suggesting that the children were following a similar growth trajectory on maths processing skills but doing so more slowly.

Moreover, just as some children with physical difficulties experience problems with maths learning when it involves visuospatial skills, some children with specific language impairment (SLI) experience problems when it involves language skills. This effect is greater in some maths tasks than in others, presumably because of variations in how crucial a role is played by language competence in each task (Crown *et al.* 2005). Working in Arizona Alt *et al.* (2014) analysed the performance of three groups of children aged 6–9 on a series of maths-related tasks that varied in the language demands they presented:

- 21 native monolingual English speakers (NE)
- 20 monolingual children with SLI (SLI)
- 20 English language learners (ELL)

They found that the ELL group had similar scores to the NE group for all the maths tasks except when on the one that posed a heavy language demand. In contrast, the group with SLI was less accurate than both the other groups on language-heavy tasks and on some language-light tasks too. Specifically, they had lower scores on tasks that involved comparing numerical symbols and using visual working memory for patterns. The authors suggested that:

Overall, the results of this study point to multiple possible problem sources for mathematical difficulties for children with SLI. These include the manipulation of mathematic symbols, the use of working memory for patterns, and the combination of complex linguistic syntax plus mathematical symbols. (p. 230)

As suggested in Chapter 10, there may be a “core deficit” behind SLI that affects the learning of any sequence-specific information.

The complex relationship between maths performance, language skills and special needs has been investigated further by Paterson *et al.* (2006) in relation to two genetic disorders. Williams Syndrome (WS) is associated with a distinctive facial appearance, a sociable manner and severe learning difficulties. Typically individuals with WS develop language skills that are more mature than would have been predicted from their overall cognitive ability. However, there is often a specific weakness in the visual systems of the brain in WS with poor depth perception and an inability to visualize how different components can be put together to make larger objects (e.g. when doing a jigsaw puzzle). The better known genetic disorder, Down's Syndrome (DS), also involves some impairment of cognitive ability as well as a distinctive facial appearance. Cognitive development varies a good deal, but DS does not normally involve visual difficulties to the same extent as WS. Paterson *et al.* (2006) predicted that children and adults with WS show a different profile of strengths and weaknesses in maths from those with DS. They matched the two groups in their study for chronological age and overall cognitive ability. The results showed that, while the Down's group did less well on the maths tasks in infancy, the performance of the older children and adults with Down's was superior to that of the Williams group on all the tests. The performance of the Down's group improved with age, following a developmental path similar to normally developing groups but consistently behind them. The developmental path of the Williams group was different: they could manage the simple processing of numerosity involved in the infant tasks, but at a later stage the relative strengths of their language skills did not appear to compensate for the impact of their weak visuo-spatial skills on all aspects of maths learning. The authors stressed the importance of differentiating between simple delay (as shown by the Down's group) and “deviant cognitive processing” (as shown by the Williams group). Detailed assessment is essential at each stage if the implications of an individual's distinctive pattern of special needs are to be fully understood. (For a more detailed account of the neuropsychological analysis see Camp *et al.* 2012.)

Many children with special needs show compensatory strengths. For instance, some pupils with visual disabilities surprise their teachers in mainstream schools by

particular success in mental computation. This appears to arise because they regularly rely on their memories rather than checking in books for what they need to know (Chapman & Stone 1988). But the same children will be handicapped if they are provided with the kind of textbook that is designed to make maths accessible and attractive for most children – visually stimulating in design, packed with illustrations, diagrams and graphs with fragments of text squeezed between them. If they are given materials designed to be accessible to them, such as shapes made of cardboard that they can examine tactually, they will explore them in distinctive ways and may name them through tactile recognition without, for example, counting the angles or sides (Argyropoulos 2002). A small group of secondary age students reported that they also felt supported when a teacher in a mainstream school talked the whole class through the detail of a diagram or other graphic material used in maths. This gave them the help they required without drawing unnecessary attention to their particular needs (Whitburn 2014).

Children with hearing impairment show a serious delay in maths attainment, on average, compared to their hearing peers, though a number of factors can mitigate that effect (Gottardis *et al.* 2011). A programme of research by Nunes (2004) and her colleagues has challenged the notion that the disability as such is a 'cause' of difficulties in learning maths because of the lack of some supposedly essential process in development. They pointed out that there is only a weak relationship between degree of hearing loss and maths test performance (Powers *et al.* 1998). They investigated children's success and errors with materials designed to minimize communication problems. With that approach they found evidence that the hearing impaired and hearing children in their sample were progressing along the same developmental path. There was no sign of a qualitative difference in their approaches to learning how to tackle more difficult problems, but there were extra hurdles for the children with hearing impairment. For example, they found it more difficult to learn the counting string and to use it to solve problems. For a brief account of Nunes' intervention programme see Activity 14.3.

Activity 14.3 Analysing the reasons for an intervention programme's success

The intervention programme developed by Nunes (2004) was designed to supplement the normal mathematics curriculum, not to replace it. It aimed to help the pupils to develop their informal mathematical understanding to "a level where it could offer a solid basis for learning the curriculum that they are taught in school". (p. 159) They were required to work through booklets that contained pictures but no text. The information was presented through drawings, diagrams, number lines, tables and graphs. Story problems were presented as temporal sequences on the page from left to right. See the figure below for an extract from a teacher's booklet that includes the instructions, which they would give to the pupils in the language they were most comfortable with.

