

Teaching Mathematics Creatively

2nd
Edition

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LEARNING TO TEACH IN THE PRIMARY SCHOOL SERIES



TEACHING MATHEMATICS CREATIVELY

Giant maths

The world of giants and their interaction with humans is an incredibly strong premise on which to base, not just one, but a series of maths lessons. The topic is so rich that it could be the subject of a whole-term enquiry, bringing with it, not only mathematics, but also a range of cross-curricular approaches, stimulating learning by involving children in a project with enormous possibilities. Children are fascinated by giants – but so are adults. Myths, legends and folk tales are littered with extremes – giants and little people (see, for example, Allan 2009). These stories rest on binary opposites of huge and tiny, power and powerlessness, or perhaps guile and force. If you spend any time crouched down or walking around on your knees, at the same height as most of your pupils, you may get an understanding as to why. Everything that children look up at is gigantic compared with them. Adults and buildings tower above them. The idea of giants, taller than all they can see, is fascinating and immediately engaging.

Begin to create in a child's mind something as simple as a visual image of a giant's hand and immediately you enter into the world of mathematic possibilities. How much wider is the hand compared with one of our hands? How long are the giant's fingers?

Source material for this work can be found in numerous children's stories. The simple story contained in the book *The Giant Jam Sandwich* (Vernon Lloyd 1988) has the potential to act as a springboard into a world of exploration around many aspects of mathematics. The illustrations and rhyming text tell the story of a village plagued with wasps. To solve the problem of the wasps, the townspeople decide to trap the creatures in a giant jam sandwich, working together in a strange and imaginative way. The book can engage a class in a range of cross-curricular activities, including cooking and exploration of quantities, size and scale, giving clear mathematical directions on how to make a sandwich, or the possibilities of a science lesson on exploring the anatomy of a wasp. Just how much dough would be needed to bake a loaf of the size used by the villagers? How much would the ingredients cost?

Another great giant book that we have based a large proportion of our work on is the story of *Gulliver's Travels*, particularly focusing on Gulliver's adventures in Lilliput. This story is rich with mathematical possibilities. In the original version, Gulliver himself comments about the mathematical abilities of the Lilliputians, their capacity to build

machines and use pulleys and ropes to haul him up off the beach, and their creative ability to solve problems using mathematical concepts:

The emperor himself gave orders to have a bed prepared for me. Six hundred beds were brought in carriages. One hundred and fifty of their beds sewn together made up the breadth and length and these were four doubled . . .

An imperial commission was issued out, obliging all the villages nine hundred yards round the city to deliver in every morning six beeves, forty sheep, and other victuals towards my subsistence, together with a proportional quantity of bread and wine . . . An establishment was also made of six hundred persons to be my domestics, who had board-wages allowed for their maintenance, and tents built for them very conveniently on each side of my door. It was likewise ordered that three hundred tailors should make me a suit of clothes after the fashion of the country.

(Swift 1993: 21–3)

Suddenly, from a reading of the above, the mathematical possibilities that surround caring for a giant, with all its intricacies, open up a whole range of work for the adventurous and creative teacher. How much taller than us is the giant? How much food do we need to feed him or her? If our giant got stuck down a well, how much rope would we need to pull him out?

The last question might sound slightly surreal, but, in one mathematics programme, children were asked to imagine that the army had locked a giant down in a well to prevent him from leaving them. The townspeople, realising this was unfair, decided to set him free. They discovered that, when the giant jumped, his hand was just 1 metre away from the top of the well, but how high could he jump? There was only one way to find out. The children jumped against a wall covered in lining paper, and a mark was made to show how high their hand could reach while they were jumping, and another to show how tall they were when their hand was stretched up in the air.

When all the class had jumped and been marked on the wall, they created a graph of measurements showing the range for the class of how high a jump could be. An average was taken, and this was used to estimate how high a giant, who was six times as big as them, could probably jump. Add this to the metre remaining at the top of the well, and they had a close approximation of how deep the well was. Next, in threes, they plaited a rope long enough and strong enough to free the giant. Weaving and plaiting in threes involved following a simple pattern of ducking and stepping over each other's pieces of string, working out the best way to move together to strengthen the rope.

The amount of mathematical knowledge needed to solve this problem was greater than the assumed ability of this Year 4 age group, but the interest and motivation, the fact that they found out which child could jump the highest and what the average jump was for the majority of the class made the learning enjoyable and relevant. The need to solve the problem in order to right the injustice that had been wielded on the poor forsaken giant spurred the class on to finding solutions. Their engagement was evident throughout the session.

With older pupils, we have engaged them in making three-dimensional props for a film about giants, organising themselves into a film company and creating short scripts that involve the use of at least one giant object discovered by a group of humans. Pupils

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MANTLE OF THE EXPERT

The Mantle of the Expert (MoE) is a drama technique that was developed and refined by Dorothy Heathcote. It is based on the belief that children learn best if they have a relationship to the subject matter being covered that is more akin to that of an expert than a pupil. Heathcote believes that engagement in classroom drama is an essential part of children's learning and is vital if we are to enhance pupils' ability to connect with the curriculum.

In her book *Drama for Learning* (1996), which she co-wrote with Gavin Bolton, Heathcote analyses her work with a variety of age groups and discusses how the MoE approach empowers children through purposeful activities. The benefits of MoE are that it gives pupils the opportunity to work together to find solutions to problems, discussing how they will proceed, what is the best thing to 'do next' and generally creating their own pathway through the learning.

As experts, children take on the role of someone who has a degree of knowledge and understanding in an area, but who needs to work on the problem with their peers to develop, through practice, the additional skills they require to solve this particular problem. Heathcote developed this methodology through a realisation that this is how adults learn in their lives: through gaining knowledge in real situations through day-to-day experiences and the demands that responding to these needs puts upon them.

Heathcote and Bolton believed that the:

Mantle of the Expert provides a centre for all knowledge: it is always experienced by the students in terms of the responsible human being ... an active, urgent, purposeful view of learning, in which knowledge is to be operated on, not merely taken in.

(1996: 32)

During MoE, pupils take on many roles; for example, they might, as in this giant example, be an archaeologist or a mathematician. The relationship of the pupils to the very real jobs that they take on engages them in finding solutions from their own skill base. The cross-curricular potential and the ability of this work to touch on very real mathematical ideas are great. For more examples of lesson plans for MoE work, visit www.mantleoftheexpert.com

were then tasked with making this prop, exploring scale and size and linking the work with design and technology to build an exact replica of the smaller human version. Once these were completed, pupils had the chance to act out their stories. Using the MoE drama technique (see the box above), the pupils were put in role as expert archaeologists and mathematicians and set the task of discovering the mathematical properties of the objects that had been made by other groups.

CROSS-PHASE GIANT PROGRAMMES

The topic of giants does not have to be restricted to any one age range. We have worked with this theme with pupils from nursery through to pupils in Year 7. The case study below identifies learning opportunities developed in a primary school.

MATHS FOCUS **A GIANT'S BIRTHDAY PARTY**

- Size
- Shape
- Proportion
- Scale
- Pattern
- Circumference
- Planning/handling data

Scenario

Long ago, the townspeople of Deptford adopted a giant from the Ministry of Giants. His name was Bigfoot and he helped around the town, cleaning the windows in the tall buildings, fetching footballs that had got trapped on the school roof and rescuing kittens that had climbed up trees. The townspeople loved having Bigfoot living with them.

Then, one day, Bigfoot disappeared. Everyone searched for him, and eventually he was found, hiding in his cave, having pulled an enormous rock across the entrance. The townspeople tried to reach him, but he would not let them in. They tried to persuade him to leave the cave, but he would not come out. So they wrote to the Ministry of Giants to find out what they could do.

An enormous letter arrived telling them they had been neglecting their giant. Did they know it was Bigfoot's 100th birthday? Had they ever given him his own plate and knife and fork to eat with? Did they ever let him have giant friends to visit from the neighbouring towns?

The townspeople felt very guilty and realised they had done nothing to thank Bigfoot for all his work. They decided to throw a Giant Birthday Party for him.

Exploration

- 1 This programme of work took place over a school day in a two-form entry school and involved all the children from Nursery to Year 4.
- 2 The children were invited to put themselves in role as townspeople and imagine that they had adopted the giant Bigfoot and they now needed to prepare for a giant party.
- 3 Nursery and Reception were tasked with making giant food, papier-mâché sausages, ping-pong ball peas and extra-long string spaghetti – mathematics involved size, shape, proportion.
- 4 Year 1 was invited to make giant party hats for the five giants – mathematics involved scale, size.
- 5 Year 2 was responsible for designing the tablecloth – mathematics involved pattern and scaling up.
- 6 Year 3 created the plates and cutlery for the giants – mathematics involved circumference, scale.
- 7 Year 4 was responsible for running the event, timetabling when everyone would place their contribution in the hall, and for making a giant birthday cake – mathematics involved timetables, using maths in planning and organisation, scale and size.
- 8 Towards the end of the day, pupils took turns to bring their class's contributions to the hall and lay them out. Once everything was set for a giant celebration, each class visited the hall to explore the story, by viewing the finished product and enjoying the work of their peers.

continued . . .

MATHS FOCUS **A GIANT'S BIRTHDAY PARTY** . . . *continued***Outcomes**

- Pupils across all age groups readily engaged with the programme and talked about the giant's party for many weeks afterwards. MakeBelieve Arts still bumps into pupils two years later who remind us that they were involved in the project.
- Discussions could be heard in each classroom about how tall the giant Bigfoot must be, making comparisons with other tall objects, using a giant shoe and golden mean to estimate his height and using the language of maths to enable them to fulfil their role in the story.
- Many pupils, particularly from Years 3 and 4, asked if the giant was really coming, despite the fact that we had made it very clear at the beginning of each project that this was a story.
- Teachers were impressed with how engaged their pupils were in the activity and how the maths that they were involved in suddenly had a purpose.
- The teachers from one school spent time after the children had left making the hall look as if five giants hadn't cleared up after a party. The children were very excited about this when they came in the next day.

Further information

When using story in this way, we are not trying to make the children believe the story is true. We are asking them to engage with the play of the story. When we work with children, we are very clearly inviting them to pretend that they are the townspeople and this is their giant.

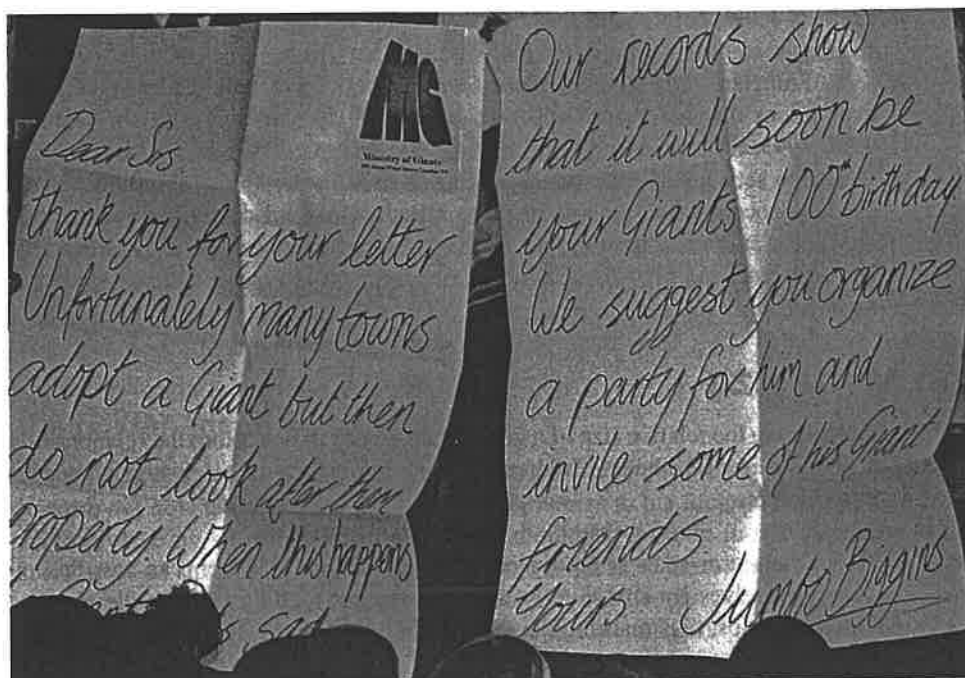
Reference

A Giant's Birthday Party is a programme developed and delivered by MakeBelieve Arts (www.makebelievearts.co.uk).

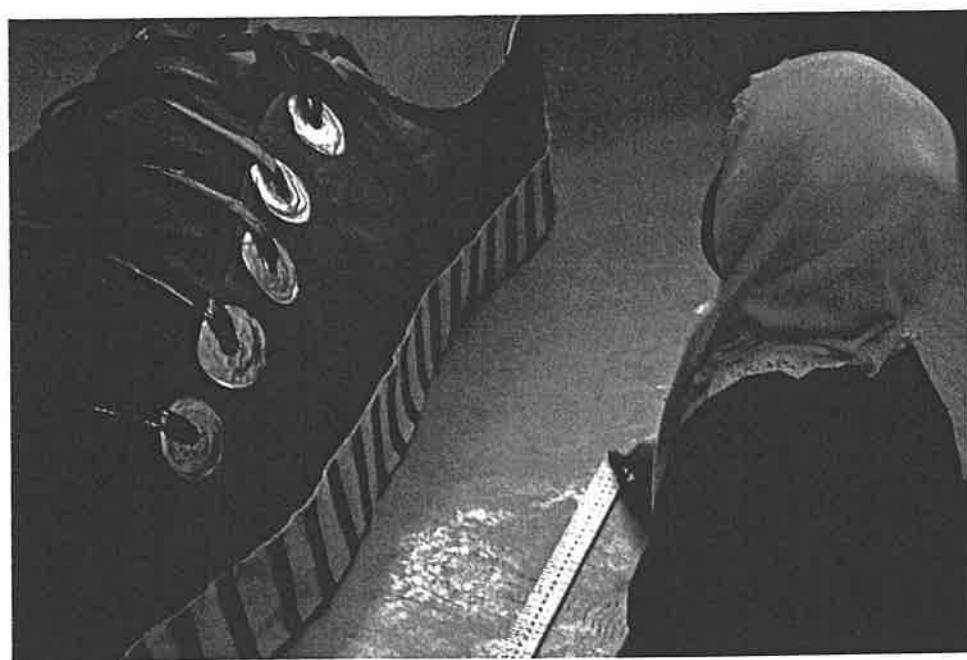
Is it real?

When children ask if a situation or scenario is real, we often ask them what they think. If they are not sure, we explore the idea of story. If we try to convince children it is real, then our focus shifts from the play potential of a good story to a debate about what is real. This does not mean we cannot fully throw ourselves into the play, like the teacher who created the morning after the giants' party. If you watch children at play, their play is very real, but it is real within the safe world of pretend. In the case study above, we have described the questioning by children from Years 3 and 4. One child in particular, from Year 4, quickly approached a member of the team and said scornfully, 'Giants are not real you know!'. At the end of the day, doubt had crept in, and the very same boy approached to ask if giants were really coming!

One teacher, who had not realised the importance of pretend and that children buy into a story within safe parameters, made the mistake of exploring the folk tale *Chicken Licken*, which tells the tale of the sky falling down. She set up a drama activity where half the class reported to the other children that the sky was falling down, but she forgot to



■ **Figure 7.1** The children received a letter from the giant



■ **Figure 7.2** The giant's shoe is used to encourage children to guesstimate the size of the giant

let them know beforehand that they were playing the story. With children in tears and frightened to go outside, she quickly realised her error.

From an early age, children learn to both give and read play signals – facial expressions that are shared and that signify a play situation (see, for example, Carson *et al.* 1993; Smolucha and Smolucha 1998). Perhaps difficulties arise when children are unused to seeing particular adults, such as those in school, in a playful or imaginary role. This may occur when schools begin to introduce playful or dramatic scenarios. Children are skilled at reading play signals, both among peers and in their play with adults. If these are being misread or missed, adults probably need to examine their own behaviour and approach.

RELATIVE SIZE

In exploring the relative size of a giant, children began to explore the relationships between different parts of the body. Children (and adults) can become fascinated by the relationships that emerge:

- One's arm span is equivalent to one's height. Children can test this out among themselves by stretching out their arms and getting two people to stand at their fingertips, thus marking the distance of the full span. If the first child then lies down in the space between the two others, they will discover that they fit well into the space marked out in this way.
- A piece of string can be used to measure the breadth of the shoulders. This will prove to be roughly a quarter of the child's height. As one child said: 'The string on the shoulders ... I thought it was amazing. I never knew my shoulder was a quarter of my body, I kept the piece of string – it's on my bedroom wall and I showed all my friends.'
- Roughly six times the length of a person's foot makes up the length of their body.
- An adult's hand is the size of their face (although we discovered that this is not true for young children, whose heads are proportionally larger than those of adults).
- The size of a foot is equivalent to the distance between wrist and elbow – a fact that staggers many adults, who cannot believe that their feet are that big.

There are countless other examples of how parts of our body divide equally into other parts, and, when they work, they feel like a piece of magic being revealed to us. There is also a fascination in all age groups that these rules remain generally true, whatever your size.

The golden mean or ratio

The famous image created by Leonardo da Vinci of *Vitruvian Man* (see, for example, O'Malley 2007) highlights many of these relationships. (If you are unfamiliar with this image or want to know more about it, see <http://ed.ted.com/lessons/da-vinci-s-vitruvian-man-of-math-james-earle> or www.bbc.co.uk/science/leonardo/gallery/vitruvian.shtml) There is believed to be a link between da Vinci's work and that of Fibonacci. *The Number Devil* (Enzensberger 2008) includes an explanation. *The Rabbit Problem* (Gravett 2009) is based on Fibonacci's theory.

■ ■ ■ ■ GIANT MATHS

Another interesting relationship to the golden mean, also drawn from Ancient Greek thinking, is the claim that the human body is based around the number 5. It is widely suggested that five has particular importance because:

- we have five appendages to our torso: arms, legs, head;
- each of these contains five appendages: fingers, toes, openings on the face (if you don't count the ears);
- we have five senses: sight, sound, touch, taste, smell; however, this alleged 'fact' is said to have emanated from Aristotle (or possibly Plato, who taught Aristotle but wrote nothing down); since that time, a range of additional senses such as echolocation and proprioception have been identified.

Using the golden mean with giants

Using the properties they have discovered from their explorations allows children to begin to work out how tall a giant is just from having access to his footprint, or a hand print, or a piece of string showing the length of his shoulders. Add an in-role character to this scenario of an anxious tailor who has been given the task of measuring the giant for a suit. She manages to take a measurement of the shoulders, but then the giant begins to get fidgety, and she gets scared, and now she has to make a suit for the giant by nightfall and all she has is the one measurement. Immediately, we can have an exploration of fractions, scale and measurements, using what we know about our own bodies to discover and mark out the proportions of the giant.

CONJECTURAL THINKING

In Chapter 1, we talked about how children need to be 'seekers and solvers of problems' (Claxton, cited in Alexander 2010), and how mathematics does not always need to have one clear right or wrong answer. As giants are probably not real, they provide excellent material for 'thinking outside the box'! When trying to find out the height of a giant, a class of children from Years 5 and 6 were placed into groups. Each group was given a metre-long giant toothbrush and a normal-size toothbrush. The children were asked to find as many ways as they could to discover the height of the giant and to mark out a masking-tape line from one end of the hall for each way they discovered. The children used a variety of approaches:

- measuring the normal-size toothbrush with their hand and discovering it was roughly the same size, so then measuring how many times their hand went into the giant toothbrush and working out that the giant was six times bigger than them;
- measuring the brush section of the normal toothbrush, finding out how many times the normal-size brush went into the giant-size brush, which was roughly eight times, and working out that the giant must be eight times bigger than one of them.

These two different answers are both logical and both involve reasoning, and yet one giant taped out on the floor was much taller than the other. The children got very excited when they realised that neither answer was wrong or right, and that both were good approaches to take, but they struggled with the very obvious difference between the

two lines. This opens up discussions about the facts we are given and how much is based on assumption. Two normal-size toothbrushes can vary immensely in shape and size, and yet we assumed that the giant toothbrush and the normal-size (child's) toothbrush that we used were comparable. By challenging the assumption that mathematics must involve right or wrong answers, we make it a more creative and interesting subject.

Changing scale – changing perspective

The potential of giant mathematics is truly gigantic. Within stories, giants can do anything at all. As we have seen, there are endless possibilities. However, it is also interesting to imagine that we are the giants and to consider the scale of those who believe us to be giants. Suddenly, rather than working with objects six times larger than themselves, pupils can begin to think about objects six times smaller, or about the size of a shoe. If the giant is a child giant, then the children can use their own feet as the example of scale. The questions that now begin to open up are, if the people are as tall as our feet, how big are the plates or the cups that they use, and what would it be like for us to have to eat or drink from these?

ACTIVITIES AND LEARNING

The topic of giants is one of many subjects that actively engage children. Is this because they embody the binary opposites that Egan (1988) tells us are necessary for a good story? Is it because, being not real, they allow for conjecture and narrative? Or are they, in children's terms, so real that they have irresistible interest? Whatever the reason, in the course of exploration of this topic with children, real tasks have led to engrossed interest and heightened learning. Excitement is essential to learning – it makes things memorable and changes the chemistry of the brain, to make learning more effective (Eliot 1999).

Children readily remember making giant plates and food. They remember having to write in giant letters and make a giant envelope, so that the letter would be large enough for a giant to read. They remember receiving a letter so tiny that they had difficulty reading it. When they were exploring the role of the Lilliputians (Swift 1993), actually collecting enough litres of water for a day's supply for a giant proved a challenging and memorable task. Giants are not the only things that excite and motivate children. Creative teaching demands that we go on finding the other interests and enthusiasms that can stimulate learning in the same way.

CONCLUSION

In this chapter, a variety of references have been made to stories and mathematical approaches that the topic of giants offers to the creative teacher. Big and little are the first comparisons made by young children (followed by male and female) and continue to be of interest throughout childhood. Thus, as seen in this chapter, giants make a perfect focus for cross-phase, cross-curricular and mixed-ability work, bringing into play a combination of knowledge and experience, such as considering the ratios on which comparative size rests. Moreover, both pattern and problem solving, key elements of mathematics, feature strongly in the work described here.

FURTHER READING

- Allan, T. (2009) *Myths of the World*. London: Duncan Baird.
 Heathcote, D. and Bolton, G. (1996) *Drama for Learning: Dorothy Heathcote's Mantle of the Expert approach to education*. Westport, CT: Greenwood Press.
 O'Malley, C. (2007) *Leonardo da Vinci on the Human Body*. London: Crown.
 Wyse, D. and Dowson, P. (2009) *The Really Useful Creativity Book*. London: Routledge (see Chapter 6 on the Mantle of the Expert).

CHILDREN'S BOOKS

- Briggs, R. (1973) *Jim and the Beanstalk*. London: Picture Puffins.
 There is plenty of potential for mathematical activities – measuring for glasses, false teeth and a wig. There are links with communication issues – tiny books for which he needs glasses, the large note from the giant.
 Dahl, R. and Blake, Q. (2001) *The BFG*. Harmondsworth: Puffin.
 Perennial favourite, with a focus on the feelings evoked by giants.
 Donaldson, J. and Scheffler, A. (2002) *The Smartest Giant in Town*. London: Macmillan.
 Again, there is plenty of potential for estimation, conjecture and measurement. How big would the sock need to be to make a sleeping bag for a fox, for example? How long would a tie need to be in order to serve as a scarf for a giraffe?
 Dunbar, J. and Dunbar, P. (2005) *Shoe Baby*. London: Walker.
 This is about a giant baby who uses his giant father's shoe as a boat, a car and a plane. It has good potential for talking about sizes and links well with drama stories based around the giant shoe.
 Farley, J. (1997) *Giant Hiccups*. London: Tamarind.
 A giantess lives peaceably until she gets hiccups, which sound 'like a hundred dinosaurs falling out of bed'. What might that sound like? Finally, the children decide that she must be hungry and make her a vegetable stew. How many vegetables would they need? How big would the pot be?
 Herrmann, F. and Him, G. (1986) *All about the Giant Alexander*. London: Piccolo.
 An old text that is wordier than the average picture book and therefore probably better for Key Stage 2 than Key Stage 1. It has good pictures that highlight aspects of size.
 Hughes, T. (1994) *The Iron Woman*. London: Faber Children's Books.
 Hughes, T. (2005) *The Iron Man*. London: Faber Children's Books.
 Ross, T. (2008) *I'm Coming to Get You*. London: Picture Puffins.
 The story focuses on the little boy's fear of a monster. Only in the final illustration does the reader find out that the monster is tiny. It offers excellent opportunities to discuss comparative sizes.
 Swift, J. (1993) *Gulliver's Travels*. Bath: Parragon Book Service.
 Swift, J. (1994) *Gulliver's Travels*. London: Penguin Popular Classics.
 Vernon Lloyd, J. (1988) *The Giant Jam Sandwich*. London: Piper Picture Books.
 Walker, R. and Sharkey, N. (1999) *Jack and the Beanstalk*. Bath: Barefoot Books.
 Wilde, O. (1982) *The Selfish Giant*. London: Picture Puffin.