"How Fast does the Wind Travel?": History in the Primary Mathematics Classroom

J. HELEN GARDNER

There may be a feeling that the use of history in the mathematics classroom is something which only applies to older pupils. Obviously the greater the mathematical sophistication of children, the more history is available to help consolidate their learning of mathematics; but my experience is that appropriately chosen history is both suitable and valuable for the mathematical training of younger children too.

The school at which I teach is a multi-ethnic primary school in the English Midlands, with many pupils for whom English is a second language; many are insecure, which adds to their language handicap. These are often anxious children who already feel lost in the escalating curriculum. They want straight-jacket directions from their teachers, and when these are not forthcoming become even more bewildered.

However, they find story-time relaxing and enjoyable, and by telling stories from mathematical history I believe that the trauma of mathematics lessons can be reduced. This is why my classes are used to my starting them off on a piece of investigation, only to have me stop them after six or seven pencil-chewing or last-night's-television-filled moments with "Come on, I'll tell you a story."

This, of course, encourages the idea—already well-established among some of my teaching colleagues—that I don't teach "proper maths" (as in working section by section through the scheme preferred by the school), but concentrate on what my colleagues call "play maths"; that is, things like finding out how far it is round a model railway track, how long it takes the train to go a complete circuit and trying to determine its speed; or finding the number of colours needed to decorate the Christmas bells; or partitioning 12; or doing probability experiments; and what they consider to be other irrelevant stuff. In each new topic I try to include some historical aspect, either a problem as a launch pad, or a brief biography for encouragement and interest, or a story to stimulate discussion or creativity

Discussion in the staff room

During a recent planning meeting I asked a colleague to work with me towards formalizing the use of historical perspectives in mathematics lessons. Readily agreeing, and taking the top "Elizabethan Times" she suggested the exercises outlined in Box 1

My colleague's response took me by surprise This wasn't at all the kind of thing I had in mind! My initial request for collaboration between us was evidently exactly, as far primary—or any—education is concerned, does "a historical perspective in mathematics" mean? There are, of course, few true mathematics specialists in a primary school. Most teachers are generalists, which is a good thing on the whole but can sometimes diminish subject sensitivity. I was not happy with my colleague's suggested teaching material, because I felt there was nothing intrinsically historical about drawing numbers and information out of a list of facts. When I told her I had been thinking, rather, of the history of mathematics she was somewhat surprised—does mathematics have a history? it just is and always has been!—but tried to humour me by suggesting I could use facts about mathematicians. ... To humour her in turn, I drew up Box 2.

Elizabeth I

1558	Accession of Elizabeth I
1561-1626	Francis Bacon
1564-1616	Shakespeare
1573-1652	Inigo Jones
1577-1580	Drake's voyage round the world
1577-1640	Rubens
1587	Execution of Mary, Queen of Scots
1588	Spanish Armada
1603	Accession of James I

Activities

1. How long did Elizabeth I reign?
2. Draw a bar-chart to show how long Bacon, Shakespeare, Jones and Rubens lived.
3. Of these, who a) lived longest? and b) had the shortest life?
4. How long did Drake's voyage last?
5. Can you name these men?
   a) He was born 42 years before Elizabeth died: he was a writer.
   b) He designed scenery for the theatre and lived the longest
   c) He was born while Drake sailed: he was a painter
   d) He lived less than 60 years and was a playwright.

Rather to my surprise, my colleague liked this—but largely because it was hardly any different in concept to her own first idea. It still failed to capture the sense of history which even children of this age are well able to absorb. This is, I am certain, *not* the way to join mathematics and history: it is far too mechanical, lacking the human dimension which is crucial both to history and to (well-taught) mathematics.

Elizabethan mathematicians

1558	Accession of Elizabeth I	1603 Accession of James I
1550-1617	John Napier	Invented first mechanical calculator, called Napier's Bones
1560-1621	Thomas Harriot	In 1585 went to map the 'New World'
1564-1642	Galileo Galilei	Tried to determine the speed of light: made telescope.
1574-1660	William Oughtred	Was responsible for the cross (×) for multiplication
1596-1650	René Descartes	Worked with graphs and co-ordinates
1588-1648	Marin Mersenne	Tried to determine the speed of sound: worked with prime numbers

Activities

1. Draw up a bar chart to show the length of these mathematicians' lives.
2. List them in order according to how long they lived Start with the man who lived the longest.
3. Find the chapter on Napier's Bones in Nuffield 6, and do it.
4. How old was Thomas Harriot when he sailed for the "New World"?
5. A prime number is one which has no factors other than 1 and itself. for example, these odd numbers 3 5 7 11 13 are prime numbers; but no even number is prime, except for 2 Why not?
6. Can you find nine prime numbers between 13 and 50?
7. Find the chapter on co-ordinates in Nuffield 5 and do it.
8. i How old was Galileo when Descartes was born?
   ii How old was Descartes when Galileo died?
   iii How old was Oughtred when Napier died?

If this is not the way, *how* can we, in primary schools, make use of mathematics history? I have previously tried to indicate *why* I use history in my teaching; there follow two examples of how history has contributed to my mathematics lessons

How fast is the wind travelling?

I was working with a mixed group of pupils from years 3 and 4 (8- and 9-year-olds) when one of the mobile classrooms had to be evacuated because of storm damage to the roof The children were excitable as they always are during high winds, so I decided to work with the wind rather than against it. I challenged the group to *find out how fast the wind is travelling*.

Now that's difficult! But I agree with the observation that the "limits on the insight and creativity of children are being set by the materials presented to them and not by the native talent of the children." [*Schools Council Curriculum Bulletin* number 1 1965, p. 97] As can be imagined we had all sorts of wild suggestions and guesses, but no real idea how to start. To everyone's relief (including mine) I had a story ready.

I outlined the story of how Mersenne measured the speed of sound. Then I caused amusement by saying that two great mathematicians, Descartes and Galileo, had completely opposite views as to the speed of light ("Did they fight?" inquired one interested soul.)

To determine the speed of sound

To determine the speed of light

I briefly described Galileo's experiment as he tried to prove himself right. We improvised across the classroom, and then across the playground. I was reliably informed that he should have videoed it and played it back in slow motion, with half the group amused and the other half nodding in agreement. This led to a discussion on how anyone in "those times" could measure time accurately if they hadn't invented stop-watches—but that's another lesson.

Finally, we discussed how this might be relevant to the problem we had to solve. Then off we went again in groups, to discuss our problem. This time we had some ideas to try. I was pleased to note that having been led towards a strategy this particular group were keen to repeat their experiment in their own time—the inclusion of a historical story had indeed interested and motivated the children as I had hoped. Box 3 is the report of one of the pupils.

Mohammed Kaleem's report

We were asked to find out how fast the wind travels We were having guesses and they were all wrong. After that Mrs. Gardner told us a story about a man who wanted to find out how fast light travels He did an experiment with a lantern and a candle He called his friend and gave him a lantern and the man had a bucket and the man covered the lantern with the bucket Then the man uncovered his lantern and when his friend saw the light he could work out how fast light travels. Then we had an idea how to find out how fast the wind travels. We decided we wanted to see the wind like we can see light So we got a piece of paper and put it at one end of the playground and when Jason Binder said go I let go of the paper and the wind blew it and I followed it and we counted the paces. It was 44 paces in 16 seconds. We did it again at playtime but it was different.

Is it REALLY time to go home?

The whole school was studying the topic of *Food* one term, with years 4 and 5—my 8- to 10-year-olds—concentrating on *Bread*. This gave me the opportunity to introduce some work based on problems from the *Rhind Mathematical Papyrus*.

First we looked at the unit fraction table, representing the divisions 1/10, ..., 9/10, which precedes six problems of dividing loaves. Discussion of the table, of how the first problem was solved, and consequent work on the five very similar problems which followed proved to be an interesting way in which to introduce work on fractions and other topics from Egyptian mathematics which are still with us today

The Egyptian method of multiplication was not unfamiliar to the children, but they had not met its use with fractions. I assumed from previous experience that these children would not be completely comfortable when working with fractions—an assessment which this work confirmed. However they enjoyed using the table and checking the calculations in the book.

One day the class visited Avoncroft, the Museum of Buildings in Warwickshire, to study the buildings connected with bread production. On our return it seemed a good idea to tackle problem 44: *Example of reckoning a granary four-angled, length of it* 10, *the height of it* 10; *what is that which goes into it in grain?*

The time available for this lesson was two and a half hours, during which I was to introduce the material and its background, and any concepts or skills needed, and then to assess each child individually as they worked through the problem. Assessment is done on a form which includes National Curriculum attainment target levels, and which in this case I drew up myself so as to draw attention to the specific learning targets attained through this experience with the Rhind Papyrus (Box 4). Although many readers of *For the learning of mathematics* will not be concerned with this particular curriculum, I include the details in order to demonstrate how extremely rich in accessible mathematical targets the Rhind Papyrus is. More generally, there is a vast wealth of elementary mathematics from the past which can be used with surprisingly young children.

Table of division of the numbers 1 - 9 by 10

1 divided by 10 gives $\frac{1}{10}$

2 divided by 10 gives $\frac{1}{5}$

3 divided by 10 gives $\frac{1}{5}$ $\frac{1}{10}$

4 divided by 10 gives $\frac{1}{3}$ $\frac{1}{15}$

5 divided by 10 gives $\frac{1}{2}$

6 divided by 10 gives $\frac{1}{2}$ $\frac{1}{10}$

7 divided by 10 gives $\frac{2}{3}$ $\frac{1}{30}$

8 divided by 10 gives $\frac{2}{3}$ $\frac{1}{10}$ $\frac{1}{30}$

9 divided by 10 gives $\frac{2}{3}$ $\frac{1}{5}$ $\frac{1}{30}$

Problem 1

Example of dividing 1 loaf among 10 men.

Each man receives $\frac{1}{10}$.

Proof. Multiply $\frac{1}{10}$ by 10.

Do it thus.	1	$\frac{1}{10}$		
	\2	$\frac{1}{5}$		
	4	$\frac{1}{3}$	$\frac{1}{15}$	
	\8	$\frac{2}{3}$	$\frac{1}{10}$	$\frac{1}{30}$

Total 1 loaf, which is correct

In the time that has elapsed since issuing the challenge "how fast is the wind travelling?" my use of history in the mathematics classroom has indeed become formalized. I was particularly keen to use this problem because I felt that it would not only challenge the more able pupil, but as the correlation with levels shows, there is also the possibility of work at lower levels for those with either mathematical or language problems.

I began the lesson by talking about Egyptian farming methods and the relative importance of bread. Then we discussed the problem in its original form [Chace, p. 109; plate 66], picking out symbols for numbers, symbols which seemed interesting (the beetle, two different birds, etc.). We also touched on what made us believe that Egyptians wrote from right to left. We then translated the question into our English, and concentrated on the aspect which I wanted to pursue—the shape of the granary and its volume.

Attainment Target	Level	Statement of Attainment
1. Using/applying	1	use materials provided for the task.
		talk about own work and ask questions
		make prediction based on experience.
	2	select the materials and the mathematics to use for the task.
		describe current work, record findings and check results
	3	select the materials and the mathematics to use for a task; check results and consider whether they are sensible.
2 Number	2	read, write and order numbers to at least 100; use the knowledge that the tens-digit indicates the number of tens.
	3	as 2, but to 1000. Use the knowledge that the position of a digit indicates its value.
	4	read, write and order whole numbers
		understand the effect of multiplying a whole number by 10 or 100.
		understand and use the relationship between place values in whole numbers.
3 Number	3	solve problems involving multiplication or division of whole numbers, using a calculator where necessary.
		know and use multiplication facts up to 5×5, and all those in the 2, 5 and 10 multiplication tables
	4	know multiplication facts up to 10×10 and use them in multiplication and division problems.
5. Number/Algebra	3	recognize whole numbers which are exactly divisible by 2, 5 and 10
	4	apply strategies, such as doubling and halving, to explore properties of numbers
6 Algebra	2	understand the use of a symbol to stand for an unknown number.
	3	deal with inputs to and outputs from simple function machines
	4	understand and use simple formulae or equations expressed in words.
		recognize that multiplication and division are inverse operations and use this to check calculations.
8. Measures	4	find areas by counting squares and volumes by counting cubes, using whole numbers.
10 Shape and Space	2	recognize squares, rectangles, . . , cubes, cuboids, . . , and describe them
11 Shape and Space	1	state a position using prepositions such as on, inside, ..., etc.

We spent a bit of time on recognizing cubes and cuboids, because this was the level I supposed the majority of the group to be working at, but I also forayed into the concept of using a symbol for an unknown number. The children then worked alone or as a group, as suited them, for about fifteen minutes, recording their decision about the shape of the granary, with their reasons. There followed work on area and volume, using cubes and cuboids of different sizes. Dienes base-apparatus was perfect for this. Following this we talked about how the Egyptians had solved the volume problem, but we had no working on our copies to help us. Some of the children assumed they doubled, though others thought perhaps there was a table somewhere, as with the fractions.

However, time was getting on, and I still had my individual assessments to do, so I set the children to work on calculating the volume. Several did this quickly, using the doubling method, though some knew the effect of multiplying by 10 and applied it. Some children could talk to me and their peers about the task and its solution, but just could not record it in writing. Since some children finished quickly, I drew a function machine and suggested that the machine worked out volumes. I gave them several different cubes and cuboids to input and the children enjoyed drawing the machine and working out the outputs from the machine.

Although I didn't manage to chat to every child, nor complete a form for more than five or six of them, I considered the lesson very successful. This belief was reinforced when several of the less able children commented how enjoyable the afternoon had been: one little lad, not previously noted for his scholastic enthusiasm, said to me plaintively "Is it *really* time to go home?"

References

Chace, A.B. *The Rhind Mathematical Papyrus.* National Council for Teachers of Mathematics, 1979 (Reprint of 1927-29 ed. pub by Mathematical Association of America)