Primary & Early Years Magazine 43

National Centre for Excellence in the Teaching of Mathematics

Welcome to Issue 43 of the Primary Magazine (incorporating Early Years). In this issue we feature the artist Jackson Pollock. We explore the mathematical possibilities around Florence Nightingale and Mary Seacole. We Focus on sundials, and Maths to share looks at research which suggests that knowledge of fractions and division predicts future performance in mathematics.

# Contents




**Image Credits**

Page header - Painting in the style of Jackson Pollock by Tomwsulcer with image of Florence Nightingale, courtesy of Wikipedia both in the public domain




# Editor's extras

**Number patterns…**

Numbers are fascinating aren't they? We thought you might be interested in these number patterns. Take a look at them and see if you can work out how they work!

**How can I use the Primary Magazine to support the teaching and learning of mathematics?**

Our Primary Magazines contain a number of regular features – for example, The Art of Mathematics and A Little Bit of History. We've now indexed these articles by type and brought them together in one place. We've also provided some pointers for how you might use specific articles to support the teaching and learning of mathematics in the classroom.

The features include:

- A little bit of history – a series of articles looking at number systems, famous mathematicians, and mathematics in history
- Focus on contains themed articles which provide plenty of opportunities to reinforce mathematical topics in interesting ways
- Maths to share - CPD for your school looks at particular issues in the teaching and learning of mathematics. These articles are designed for mathematics subject leaders wishing to deliver staff meetings or INSET sessions, although they are also useful for any teacher wishing to improve their practice
- The Art of Mathematics covers a variety of artists and artistic styles and ideas of mathematical activities to go with specific works of art
- It's in the News! takes topical news items and makes links to many different areas of mathematics, which can also be adapted for use in the Early Years Foundation Stage.

**Reminders**

**EYFS**
In future issues of the Primary Magazine we are aiming to have an article dedicated to the EYFS. If there is anything of particular interest that you would like to read about relating to this age range it would be very helpful if you would let us know.

**The NCETM Professional Lead Development Support Programme**
We are offering a programme of mathematics professional development to support teaching schools and other improvement partners (those who provide professional development) in their work with schools, colleges and teachers.

This programme offers a series of free face-to-face events for CPD leads in teaching schools and improvement agents to work together to develop their roles as providers of professional development. There are 20 places available at each primary event which will be taking place around the country during the next academic year.

By completing this programme, you will:

- be accredited by the NCETM to provide professional development in priority areas (arithmetical proficiency in primary schools/ algebraic proficiency in secondary schools and colleges)
- be supported to obtain the NCETM CPD Standard - a nationally established, widely recognised and quality assured badge of excellence in CPD provision

If you are interested in coming along to any of these events, you can find out more details (and book your free place!) in our News section.

**And finally…**

Have you heard this one…

Teacher: who can tell me what 7 times 6 is?
Child: 42
Teacher: Very good! Who can tell me what 6 times 7 is?
Same child: 24.

…or this

What did the zero say to the eight?
Nice belt!



# The Art of Mathematics
# Jackson Pollock (28 January 1912 – 11 August 1956)

Jackson Pollock has been described as a 'bearded shock trooper of modern painting, who spread his canvases on the floor, dribbled paint, sand and broken glass on them, smeared and scratched them, named them with numbers'. He was an influential American painter and a major figure in the abstract expressionist movement. He was well known for his unique style of drip painting.

## A brief history of the artist

Jackson Pollock was the youngest of five sons. He was born in Cody, Wyoming. His father was originally called LeRoy McCoy, but he changed his surname to Pollock when he was adopted after his parents died. Jackson's mother was of Irish decent, his father of Scotch-Irish decent, and both were Presbyterian. His father was a farmer and later a land surveyor for the government. Jackson used to go on surveying trips with his father: this was when he first discovered the Native American culture and the art it produced. He spent some of his younger years in Arizona and the rest in California. When he was in California he enrolled at the Los Angeles Manual Arts High School. This was his second high school: he had been expelled from the first, and later, he was also expelled from this one! He was said to have a volatile personality, which may have led to these expulsions.

In 1930 he followed his brother Charles to New York City where they both enrolled at the Art Students League of New York, and studied under Thomas Hart Benton. It was Benton's rhythmic use of paint and his independent style that had a great influence on Jackson's early work.

During the 1930s his work was influenced by the Mexican muralist painters Orozco, Rivera and Siqueiros, and by certain aspects of Surrealism ('direct expression or revelation of the unconscious moods of the artist').

From 1938 to 1942 Jackson worked for the Works Progress Administration (WPA) Federal Art Project. By the mid 1940s he was painting in a completely abstract manner using the 'drip and splash' style for which he is best known. He didn't use a traditional easel or paint brushes. He used to put a canvas on the floor or the wall and poured and dripped paint from a can. He would then manipulate the paint with sticks, trowels or knives. Sometimes he added sand, broken glass or other such material to his paintings.

During the 1950s, he was both strongly supported by critics with advanced thinking and subject to abuse and sarcasm by those who didn't understand his style. In 1956 Time magazine unkindly called him 'Jack the Dripper'.

By the 1960s, he was generally recognized as the most important figure in this type of abstract American painting.

In 1945, Jackson married the artist Lee Krasner, who became an important influence on his career and on his legacy. It was only after his death however, that she received recognition for the artwork she produced in her own right.

During his lifetime Jackson enjoyed fame and notoriety, regarded as a mostly reclusive artist. He struggled with alcoholism for most of his life. In an attempt to fight this he underwent Jungian psychotherapy. One of his doctors decided to work with Jackson through the use of art, and many of his paintings during this period have a Jungian influence. Some people believe that he might have had bipolar disorder.

Pollock died at the age of 44 in an alcohol-related car accident. In the December of the year he died, he was given a memorial retrospective exhibition at The Museum of Modern Art (MoMA) in New York City, followed by a larger exhibition there in 1967. More recently, in 1998 and 1999, his work has been honoured with large-scale exhibitions at MoMA and at the Tate in London.

**Some mathematical ideas for Pollock's art**

These ideas are not exhaustive, and a browse through Pollock's galleries on the internet will show many of his paintings which can be used to inspire mathematical links. You could start your browsing at ibiblio, which includes the sizes of Pollock's paintings.

If you are able to, you could show the children this YouTube video clip of Jackson Pollock painting in 1950.

Go to JacksonPollock.org. When you enter the site you can make your own Jackson Pollock-style abstracts: it's great fun, and the children will love it!

Show the painting The moon-woman cuts the circle.

Can the children identify the moon-woman? Look at her leg that is bent. Can they name the types of angles that it is bent at and estimate their sizes? You could print out a copy of this painting and ask the children to measure the angles to see how close their estimates were.

They could make their own version of this painting. Encourage them to draw the head, arms and legs of their figures in a ratio to its height of their own choice - for example, three leg-lengths to height, one arm-length to height. How do their ratios affect the look of the person? They will need to make sure they have a leg bent at two angles. They decide what type of angles and the approximate sizes to make them.

Show the painting The Flame.

This painting is oil on canvas, and its size is 51.1cm by 76.2 cm. Give the children large pieces of paper. They could measure a border of the size of the painting and then make a copy of it inside their border. You might encourage them to mix paints to different ratios to get similar shades to Pollock. They make a note of their ratios. The class could guess what these ratios are when they see the children's paintings.

The children could convert these measurements to inches and measure in these if you have suitable rulers. They could also scale the size of the painting down by half, quarter or a unit fraction of their choice and make a smaller version. They could also scale the measurements up to make larger copies.

Show The teacup.

Ask the children to tell you what shapes they can see. They could paint their own version of this, using squares, ellipses, circles and hearts. This painting is 40in by 28in. They could convert from imperial to metric and repeat the activities suggested

for The Flame.

Show The key.

The key is 59in by 48in - you could repeat some of the activities as above for The teacup. You could also ask the children to estimate the number of colours Jackson used in this painting. Give them a copy and ask them to work with a partner to count them. Can they paint an abstract picture using as many colours?

They could make a colour shading chart with colours similar to ones in the painting. They write down the ratios of the different paints that they used.

Show Pollock's untitled abstract expression.

You could ask the children to make a symmetrical abstract by dripping one colour of paint on one side of a folded piece of paper. They then fold, press, and open it. How does it compare to Pollock's?

**Information sources:**

- JacksonPollock.com
- National Gallery of Art
- Wikipedia.

**Image Credits**

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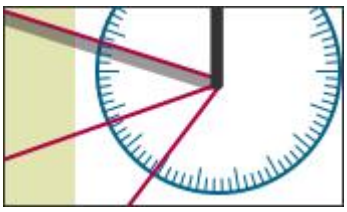




# Focus on…The mathematical opportunities of sundials

*This is the third article based on the work Steve Pratchett carried out in some of his local primary schools. You can find out more about Steve in Editor's extras in Issue 41.*

This article describes Steve's project on sundials with the children in Year 6 from Pilgrim Primary School, Plymouth, in the autumn term of 2004. In this article we give a taster of the mathematical opportunities of the project. You might be interested in reading Steve's full account, which highlights the opportunities for links with geography and science. The specific opportunities for mathematics involved position and movement, with an emphasis on angles, measurement - including time and temperature, and handling data.

For this project you will notice that Steve made a detailed scale model of the school. This is lovely but not absolutely necessary. It is sufficient to make a simple model from cardboard boxes and a playground of grey card or sugar paper on which to place a miniature shadow stick. The only essential is that the model should be moveable.

Here is the model Steve made:

One of the activities the children carried out was to find out whether it is the sun or the earth that moves. They did this by setting up a shadow stick in their school grounds to track the movement of the sun's shadow during the day. Back in the classroom, they replicated this activity using a miniature replica of the shadow stick located in the same position on the model of their school, where an overhead projector was used to simulate the sun.

(l) a group of children orientating their shadow stick and 360° bearing rose in the school grounds by using a magnetic compass; (r) the children replicating the activity on a model back in the classroom

The shadow stick, both outside and on the model, was set in the middle of a 360° bearing circle orientated North/South using a magnetic compass.

In the school grounds, the children recorded the position, length and direction of the shadows cast by the shadow stick every hour by using lengths of coloured wool. On a playground, chalk would be more suitable, but on this occasion the children were working in a grassy area, so they pinned out the wool using tent pegs.

(l) measuring the length of the shadows using a metre ruler; (r) a group recording the first shadow at 10am using a length of red wool

The shadow lengths were measured using metre rulers or tape measures and the bearings of each recorded. The children soon began to notice that not only did the length of the shadow change, but also the amount of turn or rotation of the shadow each hour increased towards midday.

The shadow's rate of movement became a fascination for the children. They were keen to see if the movement was discernible and became excited when the shadow moved measurably during one minute (approximately half a degree). This led to some quick mental arithmetic to calculate the 'speed' of rotation in degrees per minute and predictions for an hour.

Meanwhile back in the classroom, the children were faced with the problem of adjusting the shadow on their miniature 360° disc set in the school model to match the one recorded outside every hour. The majority of the group instinctively moved the overhead projector (the 'sun') to make the necessary adjustment! One boy intervened and said, "You can't do that. I've seen it on TV from outer space...the earth turns round and the sun doesn't move."

The level of excitement and engagement at this point was palpable! The overhead projector was returned to its original place in the firmament! It wasn't long before the base of the model was grabbed and Pilgrim Primary School was propelled 'through space' across the floor until the children watching the miniature shadow stick shouted "stop!" as the shadow cast reached the correct bearing.

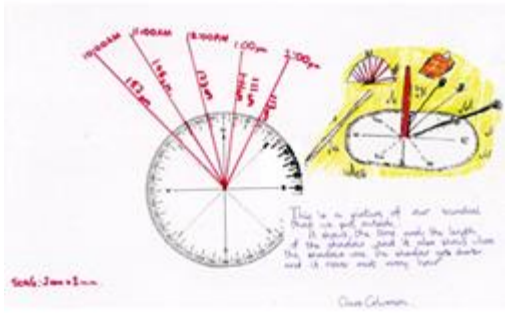
While two children watch the shadow on the miniature 360° bearing disc, the rest of the group move the 'school' in relation to the 'sun'

In addition to recording the length and rotation of the shadow, the children also measured the angle of elevation of the sun. A piece of string was tied to the base of a tent peg at the end of each shadow and stretched up to the top of the shadow stick. A large 180° protractor was used to measure the angle of elevation. Children should not take a visual sighting from the tent peg through the top of the stick to the sun because of the dangers of eye injury. By using the miniature shadow stick on the model, a piece of cotton could be extended from end of shadow through top of stick right through to the overhead projector mirror. This reinforces the process executed outside and the concept of elevation.

(l) children measuring the elevation of the sun by linking the end of the shadow to the top of the stick with a piece of string; (r) recording the length and bearing of the shadows and the sun's elevation an hourly grid

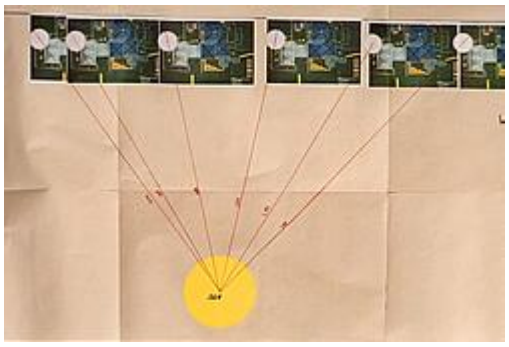
During the whole day's investigation into sunshine and shadows, the children were involved in a variety of ongoing methods of recording and communicating which were up-dated each hour.

One of their methods was to create 360° bearing charts, which involved the children drawing the shadow lengths at the correct bearing and to the correct scale. The latter was calculated by the children themselves to be 1cm = 1mm.

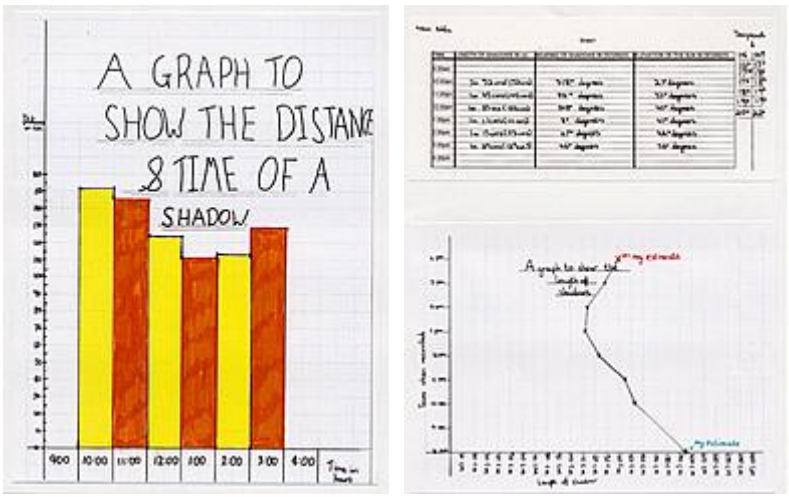
(l) recording the bearing and length of shadows to scale on a 360° bearing chart; (r) a finished bearing chart

Another method for recording was a 'moving school' chart, which involved the children in using aerial photographs taken of their school model from a previous activity. On each photograph they stuck a miniature 360° bearing disc oriented North/South. Each hour they drew the shadow in at the correct bearing and moved the respective photograph along until the shadow line could be extended to reach the centre point of the sun.

(l) collaborative work involving aligning photograph, bearings and the sun, extending the shadow and gluing down the photographs; (r) completed chart showing the 'movement of the school' relative to the sun between 10am and 3pm

The children also made graphs correlating shadow length, bearing, or sun's elevation against time. During the day, the children produced a variety of bar, bar line, or line graphs according to their attainment levels. As recording did not begin until 10am and finished at 3pm, some of the graphs included predicting forwards and backwards on the basis of the pattern emerging. Interest was aroused by the shortest shadow appearing at 1pm and not 12 noon, which led to the discussion of clock alteration for summer and winter time.




(l) a child's bar graph of shadow length every hour; (r) a child's chart of recordings made in the field and the resulting line graph, showing length of shadows and predictions for 8am and 4pm

Another activity that the children wanted to carry out was to record the temperatures in the sun and the shade and amend their hourly recording grid accordingly. They used digital read-out thermometers which give an almost instant reading. There proved generally to be a 1° – 3° difference between the two temperatures, as well as a rise of about 4° during the day. The children deduced from this that shaded locations in the school grounds had lower temperatures than those exposed to the sun, and that the temperatures were higher as the elevation of the sun increased.

Children recording temperatures in and out of the shade using digital thermometers

This was a very successful project and we hope it has inspired you to have a go at linking mathematics to any topic you might do around the sun.



## A little bit of history
## Florence Nightingale and Mary Seacole

In this issue, we look at the mathematical opportunities within the topic of Florence Nightingale. She lived from 1820 to 1910 and was fondly known as 'The Lady with the Lamp'. In addition, we look at the life of Mary Seacole, who, like Florence Nightingale, also nursed during the Crimean War. If any of you have a particular history topic that you would like us to find some mathematics links for, please let us know and we'll do our best to put something together for you.

Due to the large amount of ideas and resources, this feature can only be read directly on the portal, otherwise the interactive nature of the way they are presented will be lost.

**Image Credit**
Page header - image of Florence Nightingale, courtesy of Wikipedia in the public domain



## Maths to share – CPD for your school

## Knowledge of fractions: predictor of future achievement

In this issue we look at some research, Early Predictors of High School Mathematics Achievement, by Siegler et al. which suggests that a child's knowledge of fractions and division predicts their future mathematical achievement. Why not use this research as an opportunity to consider how you, as a school, teach these areas of mathematics, and whether there are ways in which you could improve your provision? You will need to print out pages 1 to 11 of the research and give copies to colleagues to read prior to your meeting.

In this article we pick out some key points which are worthy of discussion. You will notice that the research refers to kindergarten to fifth grade: kindergarten to fifth grade in the US is equivalent to Years 1 to 6 in English schools.

Page 3 of the report states:

> *Marked individual and social class differences in mathematical knowledge are present even in preschool and kindergarten. These differences are stable at least from kindergarten through fifth grade; children who start ahead in mathematics generally stay ahead, and children who start behind generally stay behind.*
>
> *These findings suggest a new type of research that can contribute both to theoretical understanding of mathematical cognition and development and to improving mathematics education. If we can identify specific areas of mathematics that are most consistently predictive of later mathematics proficiency, after controlling for other types of mathematical knowledge, general intellectual ability, and family background variables, we can then determine why those types of knowledge are uniquely predictive and can increase efforts to improve instruction and learning in those areas.*

It is generally accepted that children from poorer socio-economic backgrounds do less well in school. Ask colleagues to think of two or three children that were deemed lower attaining when they were in Year 1, and to consider the progress they made throughout primary school:

- what was their general intellectual ability and family background?
- did they stay behind their peers throughout school?

Do the same for children that were considered higher attaining in Year 1.
Does this correlate with the report? Why do colleagues think this is?

Discuss these points made on pages 4 and 5:

> *…numerical development involves coming to understand that all real numbers have magnitudes that can be ordered and assigned specific locations on number lines and that can be combined arithmetically.*
> *…the central conceptual structure for whole numbers, a mental number line, is eventually extended to other types of numbers, including rational numbers and negatives.*
> *…a complementary, and equally crucial, part of numerical development is learning that many properties that are true of whole numbers – having unique successors, being countable,*

*including finite number of entities within any given interval, never decreasing with addition and multiplication, etc – are not true of numbers in general.*
*…fractions provide the first opportunity to learn that a variety of salient and invariant properties of whole numbers are not true of all numbers (for example, that multiplication does not necessarily produce answers greater than the multiplicands that produce them).*
*…This view of fractions as occupying a central position within mathematical development differs substantially from the large majority of theories in the area, which focus on whole numbers and relegate knowledge of fractions and other types of numbers to secondary status or ignore them altogether.*

Are colleagues familiar with the terms mentioned? If not, go through those they are not sure about so that they gain an understanding.

Discuss when colleagues work on these different aspects of number with their children. Make a note or create a progression map of what they say from EYFS to Year 6 or whatever is appropriate to your setting. Is there a progression? If there isn't or there are gaps, maybe this is something you, as a school, should work on.

Specifically consider fractions:

- when does work on fractions begin?
- map out the progression of the teaching of fractions from EYFS to Year 6 as appropriate
- is the early work in reception built upon in Year 1? Some popular published schemes do not cover fractions in Year 1
- how often are fractions taught? If your school is still following the NS framework blocks this might be just once a term. Is this enough?
- do colleagues teach fractions within the context of number, money, shape and measures or just when fractions come up in their medium term plans? Is this something that needs addressing?
- in which year group, if any, is the teaching of fractions weakest?
- many teachers express that they find teaching fractions difficult and that the children find it difficult to learn. Is this a common view of colleagues? If so, what can be done to change that?
- what importance do colleagues place on the teaching of fractions?

It might be necessary to remind colleagues who don't see fractions as being important, that fractions help children to understand the nature of numbers and their interactions - for example, division. If children don't understand how fractions work, they are likely to find algebra difficult when they study it in secondary school. Working with fractions introduces some of the essentials of number theory, such as lowest common denominator, greatest common factor, and prime factorisation.

Fractions also have an important role in the workplace. Many of the numbers encountered in business today are percentages and various rates - for example, interest rate, employment rate, productivity level, etc. We need to help enable children to develop their understanding of how to use and interpret fractions to aid their future financial success in society.

As a group, consider why primary school children's knowledge of fractions might be crucial for later mathematics learning. Pick out this point in the research:

> *Lacking understanding of fractions, students cannot estimate answers even to simple algebraic equations. For example, students who do not understand fractions will not know that in the equation $\frac{1}{3}X = \frac{2}{3}Y$, X must be twice as large as Y, or that for the equation $\frac{3}{4}X = 6$, the value of X must be somewhat, but not greatly, larger than 6. Students who do not understand fraction magnitudes also would be more likely to use flawed equations, because they could not reject them by reasoning that the answers they yielded were impossible. Consistent with this analysis, accurate estimation of fraction magnitudes is closely related to correct use of fractions arithmetic procedures.*

Siegler et al. hypothesised that ten-year olds' knowledge of fractions would predict 16-year olds' algebra knowledge and overall mathematics achievement.

Give colleagues a few minutes to read the method, results and discussion of their work (pages 6 - 11) and lead a discussion around the results and discussion.

Clearly from this research fractions are very important to mathematical achievement (page 11):

> *The present findings imply that mastery of fractions and division is needed if substantial improvements in algebra and other aspects of high school mathematics are to be achieved. One likely source of students' limited mastery of fractions and division is that many U.S. teachers lack a firm conceptual understanding of both fractions and division.*

The draft of the next Primary National Curriculum has these expectations in its programmes of study for KS1:

Year 1:

- recognise, name and write $\frac{1}{2}$ as one of two equal parts of an object, shape or quantity
- recognise, name and write $\frac{1}{4}$ and $\frac{3}{4}$ as parts of an object, shape or quantity
- find $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{3}{4}$ of a shape or quantity.

Year 2:

- recognise, name and write fractions $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{2}{3}$ and $\frac{3}{4}$ of a whole
- count in halves and quarters to ten.

How do colleagues view these?

What needs to be put in place in your school to make this possible?

Do you need to put staff development in place to help colleagues?

If the answer to the last question is 'yes' you might be interested in using Fractions in the Early Years and KS1 from *Maths to share* in Issue 36 of the Primary Magazine and/or Fractions, decimals and percentages in Issue 17.

You might also be interested in *Maths to share* in the next issue (Issue 44) of the Primary Magazine, where we will be looking at the work of a Mathematics Specialist Teacher, who describes how the use of fraction strips and cubes enhanced the teaching and learning of fractions with a group of Year 6 pupils.

She discusses how the resources made the fractions seem more 'real' to the children and allowed them to visualise many of the concepts involved, while also allowing them to transfer the skills they were 'physically' doing into written methods

We hope this exploration of the research by Siegler et al. has given you food for thought and provided useful ideas for your school to consider if appropriate.

**Reference:**

Authors: Robert S. Siegler, Greg J. Duncan, Pamela E. Davis-Kean Kathryn Duckworth, Amy Claessens, Mimi Engel, Maria Ines Susperreguy and Meichu Chen: Early Predictors of High School Mathematics Achievement.

**Image Credit**

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