

# **YO HO HO-RATIO: SOME MATHEMATICS OF TRAFALGAR**

**(How Lord Nelson inspired curriculum development in mathematics)**

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## **ABSTRACT**

This workshop is based on mathematics masterclasses with 13/14 year old learners for 2.5 hours and a series of 10 one-hour lessons with lower secondary pupils in my mathematics class at school. It covers the history of the battle of Trafalgar (21 October 1805), and how Lord Nelson may have used mathematics in a variety of situations. The session will be done in the period costume of a sailor of 1805, explaining the social conditions and mathematics of the time.

The mathematics includes

- 1) mental geometry, visualising ships from different positions
- 2) links between algebra and geometry in the piling of cannonballs
- 3) using a mathematical text of the time to calculate the number of cannonballs in a pile
- 4) making a pair of parallel rulers
- 5) comparing two data sets using statistics
- 6) working with probability on the crown and anchor game
- 7) equations of motion to calculate the cannonball's speed and damage done

The workshop will give people a chance to work through some of the materials and see how historical incidents can be used to motivate learners. A CD-ROM with all the worksheets, pictures and notes will be given free to all those attending the session.

## **1 The starting point**

The work that follows was set up to be both cross-curricular in nature as well as being functional and covering all areas of mathematics. It was also fun to develop! It is a source of motivation for learners to see how mathematics has been/is used and applied. Sometimes it is used to teach new topics, but mainly it reminds learners about techniques taught in previous lessons as well as taking them forward with new learning.

This work is tackled by learners across the whole attainment range by carefully selecting the materials to use and going as far as is appropriate with their learning. Recently developments with this work include more attention paid to citizenship issues such as the improvement of conditions on board ship, the importance of morale and working as a team and the reduction in corporal punishment.

In 2004, I acquired some old cannon balls. With the approach of the 200<sup>th</sup> anniversary of the battle of Trafalgar, I decided to incorporate these cannon balls into a mathematics lesson to explore how they are piled and the destructive effect they had on ships. The objective was to look at the resulting number sequence and use concrete materials to see how the patterns arose, fitting in with the UK's new Programs of Study - *Key concepts*: competence in mathematical procedures, applying mathematical processes to unfamiliar concepts.

A number of mathematical opportunities arose as I started to read about the battle of Trafalgar and these seemed too good to miss, so I developed it into a two-week module of work that covered all areas of mathematics.

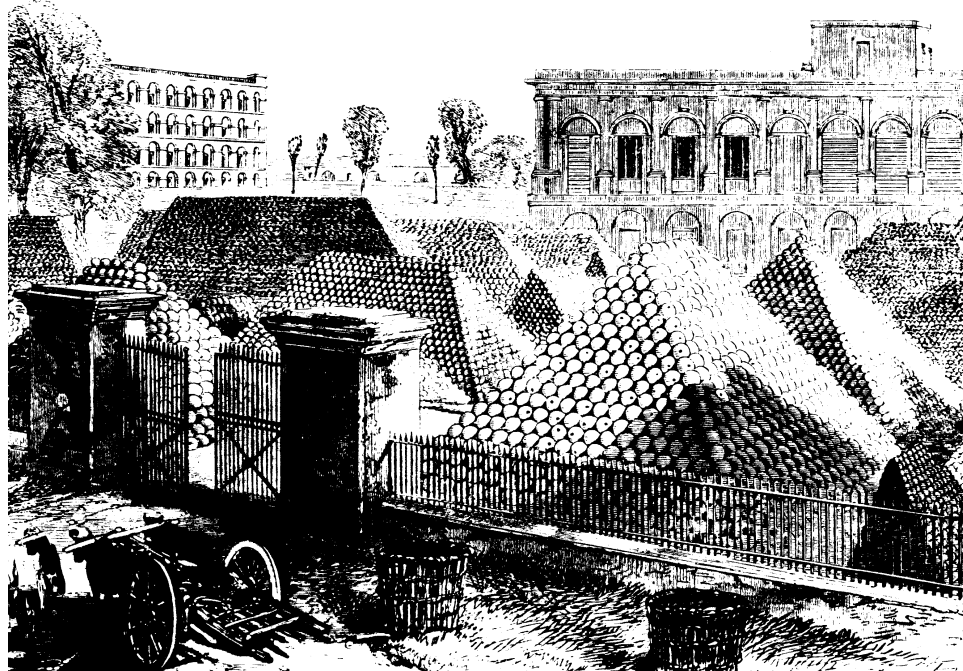
I have always used government guidance with ‘a light touch’, following it in the spirit in which I believe it was written and in what I believe to be the fun of learning – enjoyment, motivation, interest and application. I know that if I get this right then learners are involved in their learning and do not forget what they have learnt.

The work is currently also used as a 2½ hour masterclass on Saturdays as well as a two week module for Year 8 (12/13 year old) pupils in school. Madeleine Shiers, a local primary teacher and I often work together in period costume with Year 5 and Year 9 groups of learners.

## 1.1 The work

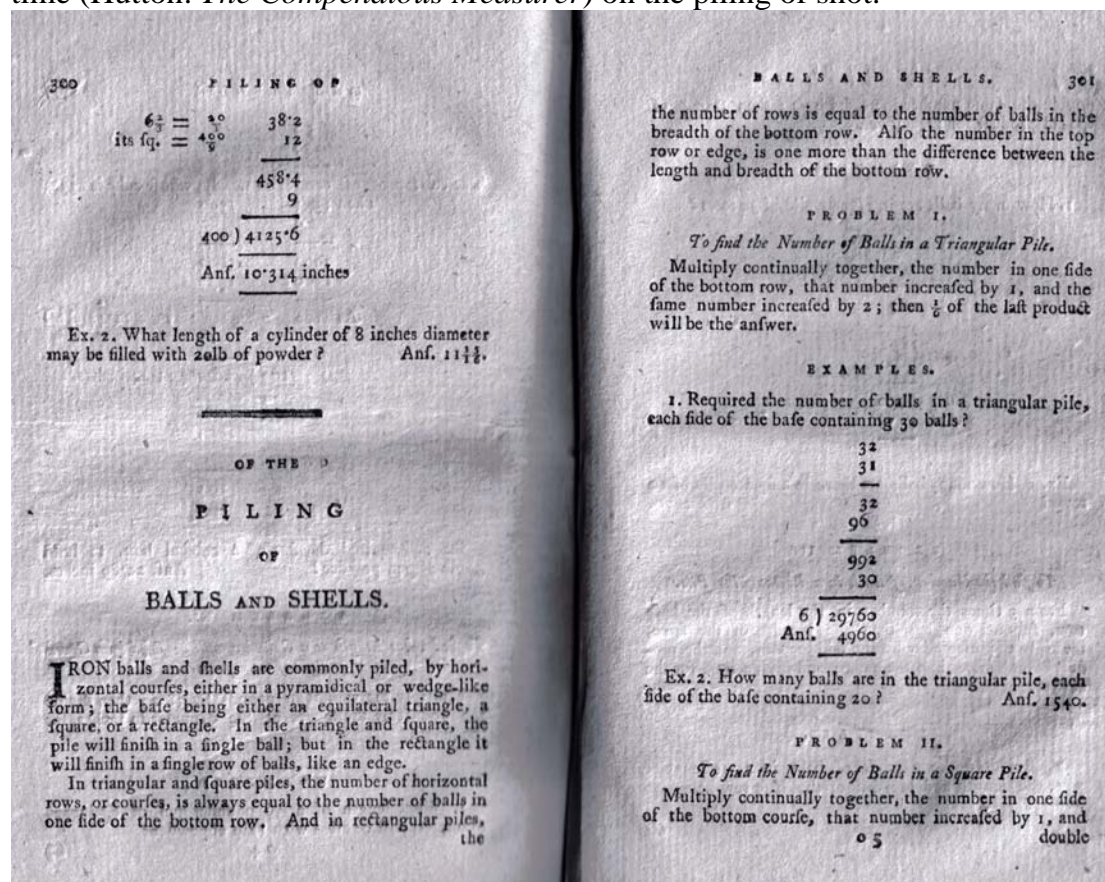
Learners are given an introductory explanation to how Nelson split his fleet of 27 ships into two columns to divide the French & Spanish fleet of 33 ships into three sections. Then the plan was for each group of 13 or 14 to engage an enemy group of 11 while the first 11 enemy ships had to sail round to rejoin the battle. This is an example of game theory (divide, defeat, regroup) which they meet in certain board games. It fits in with the UK’s new Programs of Study - *Key concepts*: appreciation of mathematics, current applications of mathematics.

They then work in groups of three and name their group after one of the ships at Trafalgar. In the first lesson they work with cannon balls (plastic play balls), piling them into square-based pyramids and filling in the first worksheet that looks at the number pattern that emerges. The use of concrete materials helps the abstract thought processes needed to extend the pattern. High attainers go on to find the formula that gives the number of cannon balls in a pyramid. They then look at a 19<sup>th</sup> century picture and calculate the number of cannon balls in a large pile.



Cannon balls piled in an ammunition store at Calcutta c.1850  
How many are in the pile by the gate?

Higher attainers read, compare and apply the formula from a textbook of the time (Hutton: *The Compendious Measurer*) on the piling of shot.



Hutton's *The Compendious Measurer* shows how to find the number of cannon balls in a triangular pile.

Algebra features highly in this work (so we can link in the *Key process* of analysing) as well as the following *Key concepts*: competence in mathematical procedures (applying mathematical processes and algorithms, reading and understanding texts with mathematical content).

The second sheet encourages weight estimation. There are four cannon balls (actually PE shot); the lightest and heaviest are stated. They lift the cannon balls and estimate the weight of the other two.

The third sheet deals with the coinage of the time.



The coinage of late 18th century Britain

Learners have a table of some of their values and complete the missing values reasoning them from other parts of the table. This brings together direct and inverse proportion. Low attainers contribute to the group work by finding out how old the coins are from their dates.

Probability is covered by playing the game 'Crown and Anchor'. If crown and anchor dice are not available then ordinary dice can be substituted. The arithmetic involved concentrates on finding running totals of the amounts won (or lost) and high attainers go on to examine the probability of making a profit on the game.

There is more arithmetic to be done and this is used in conjunction with handling data. The number of guns and men on each of the ships is given and pupils compare the two databases using measures of location and spread. A template allows pupils to compare the two data sets visually using a pyramid diagram and learners write a report comparing the two fleets for King George III. Some learners did this by making a replica scrolled document.

Further information gives the numbers of casualties (wounded and killed) on each ship and this allows further comparison of data sets. As expected, those ships near the front of the column have more casualties than those further back. This means the information allows us to work with the *Key processes* of representing, using appropriate mathematical procedures, interpreting and evaluating as well as communicating and reflecting.

One worksheet concentrates on locus. Learners draw the locus of the French/Spanish cannon balls and see how the British were under fire. Another set of instructions uses and applies geometry to make a navigational instrument called 'parallel rulers' from an A4 sheet of card. This is then used with a sea chart to measure the bearing of some ships. If sea charts are not available other maps can be used. This also illustrates how mathematics and geography complement each other. The *Key concept* of creativity features in this section since learners have to make many connections between different areas of mathematics and have to cope with unfamiliar problems.

The work appeals to the visual, auditory and kinaesthetic learner. In my opinion it is far better done with a class of learners split into small groups rather than have them work individually since the discussion is essential for learners to

voice and refine their ideas. The *Range and content* in the work enables the learner to apply their knowledge, skills and understanding to relevant real-world situations including the following.

Number and algebra: rules of arithmetic, applications of ratio and proportion, algebraic expressions, formulae and sequences

Geometry and measures: construction, loci and bearings, scale

Statistics: presentation and analysis of data, experimental and theoretical probabilities, applying statistics to enable comparisons.

## **1.2 Benefits of the work**

The following comments come from feedback sheets from pupils who have encountered the work. They were asked ‘What have you learnt?’ The spelling remains the way it was written.

*How many days since the battle of Trafalgar - 73540 days.*

*I learned a lot about Trafalgar and battleships. I also learned lots about mathematics.*

*How much money was worth. Very fun.*

*I learnt that when a cannonball is dropped from a certain height it can go 5 metres per second.*

*About the battle of Trafalgar, how they stored cannonballs and how much damage they can cause.*

*It was brilliant, not only did I learn about (maths) But I learned some history too. If I could I would do it again. I think the cannon balls were my favourite.*

*At school I find history dull but this was really interesting.*

*That a cannonball can do a lot of damage. And to work out the total of ..... 3 digit numbers and find quicker ways to work it out.*

*That Victory's cannonballs would do 400x more damage than a 16 pound cannonball.*

*I learnt about Trafalgar and the battle and ratio.*

*I learned a lot about history and maths.*

*Today i learnt a lot about cannons. I also made some new friends.*

*I learnt a lot more about olden day money and I think I am doing better at multiplication and division.*

*I learned so much that I can't write it all down.*

*Much about cannons, splinters, balls, boats and numbers.*

*I learned lots about Maths and Trafalgar.*

*I learnt a lot about Trafalgar and maths that I didn't know.*

*I learnt about the battle of Trafalgar and how you can use Mathematics. If you put your brain to you can always do it.*

Taking about the composition of the ship's crew as a complete cross-section of society from gallows cheaters to the landed gentry showed learners how people from different backgrounds operated as a team. That and the fact that the British navy had good morale, made people believe in themselves. Other citizenship issues covered the harsh punishment at the time and how forward-thinkers like Nelson reformed the navy by reducing punishment and encouraging the crew.



This work has proved popular with all learners. This is because they see a purpose to the mathematics – it is not just number crunching or pattern spotting for its own end. Linking it in to a historical event holds learner's attention. Working in small groups encourages learners to communicate with others.

The development of this work has involved much risk taking, but that is all part of the enjoyment of teaching mathematics!

### 1.3 The workshop

The workshop will give participants an opportunity to try some of the material themselves. To show about 10 hours of pupils' materials a PowerPoint presentation will be used to talk through some of the activities as well as to give participants the chance to make a set of parallel rulers and explain why the geometry of the linkage ensures that the sides remain parallel.



A set of parallel rulers made from an A4 piece of card

Activities such as this and the visual and kinaesthetic links between geometry and algebra help consolidate learners' mathematical knowledge. Pupils' work will be on display showing how they interpreted the work and used it to interpret a variety of statistics comparing two data sets. The work has recently been developed further with older pupils in the form of a card game that leads on to the drawing of proportional pie charts and the calculation of probabilities. Probability is developed further with high attaining pupils through the use of crown and anchor dice. We will play one game to give a flavour of how it is played and participants can do the analysis of the situation to calculate the probability of winning as a player in their own time.

Mention will be made of how the time invested in the use of these materials has in fact, gained time. Although I have an official scheme of work to follow, the use of these materials has allowed pupils to gain more insight into the application of various techniques and aid understanding. This has resulted in the standard bookwork being completed at a faster rate than normal due to the motivational nature of this work.

All participants will receive a free CD-ROM with all the materials. This also includes a full set of lesson notes describing the objectives of the lessons and how to work with the materials. These materials have been used many times in Saturday morning mathematics masterclasses as well as in my own classroom. I hope that there will be time for discussion at the end of the workshop for those present to comment on the materials and suggest how they can be improved with possibly other relevant mathematical sources. Hard copies of all the materials will be available for inspection, the CD-ROM providing everyone with the opportunity to use them at their convenience.

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