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Teacher Notes

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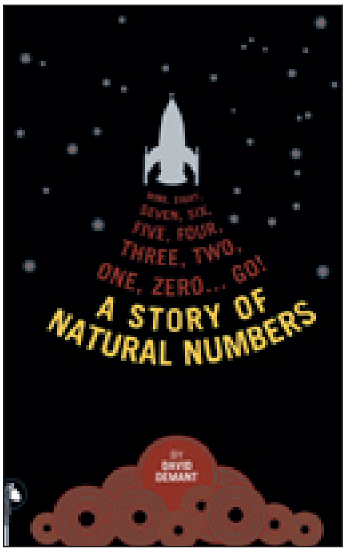


A Story of Natural Numbers by David Demant

Teachers notes by Rob Vingerhoets

Well you have to like any book that might lead kids to consider the possibility that it wasn't actually us teachers who invented numbers, but that they came about like all good inventions come about – out of a very real and practical need.

You can't really understand the contents section of this very book unless you know the symbols for the numbers and what they relate to (ie. page numbers).

I really like the summary on page 6 for a simple statement of how numbers transcends education – maths is about life, not about learning algorithms in classrooms.

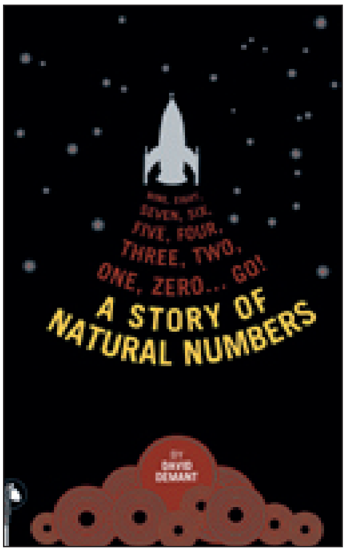
- Don't pass up on some of the suggested exercises (pages 9, 12, 15, 17, 36, 52, 63, 69-70, 83 and 88). The exercises range from early primary to lower secondary and from basic to quite complex.
- The profiles of early and significant mathematicians who paved the mathematical way for us all to follow are a very good feature of the book (from page 85 to 113) and feature individuals such as Albert Einstein and Hypatia. Hypatia (and the profile of Mary Edwards) send positive role model messages as we can tend to think of maths as being dominated by males.
- Choose carefully and wisely from the sprinkling of jokes found through out the book – humour is always very personal but there's a good chance if it makes you groan rather than chuckle it might best be left untold! PS I do like the old 'nice belt' one on page 12!

A Look At Natural Numbers

- Have your students put together a time line of who they believed first used numbers – or symbols for numbers – and describe what they may used these numbers/symbols for. For example:

early cave people	counting people in their clan
first farmers	counting buffalo they owned

- Have the students do the 'Everyday Numbers' activity as suggested by the author on page 4 but have them include an additional 5 of their own.
- As a follow up have the students list at least 10 occupations where using numbers is a crucial/essential/necessary part of the job.
- I sometimes set my students or even adults the challenge of naming something that can't be connected to maths or numbers. Someone may suggest something like dreaming or a dream. I ask, what time did you dream this?



did the dream wake you up – what time was it when the dream woke you up? how long did the dream last? A rock? How heavy is it? What is its shape? Its circumference? Where was the rock located? Try and see how you go. Then reverse it and you nominate objects (animate and inanimate) and the students need to make a connection to maths/numbers.

- To complement the notion of number as an idea (p 9) you can use an activity that I call Tell Me Something About.... Let the children (prep to any age) know the number (for example, 36) and have the students tell you something about that number. Whenever I do this I tell the students that they don't need to call out or even put their hands up because I will choose them – and don't worry you won't miss out because I'm going to give everybody a turn. Inform the students that they should not feel pressure to 'wow' you with their mathematical knowledge. It just has to be something true about that number – it can be personal (age, house number, favourite player's number), visual spatial (both digits are very curvy), relate to sometime or place they have seen or heard it (it was 36 degrees in Melbourne today) or mathematical (it has a lot of factors, it is 6 x 6, the digit in the tens is half as big as the digit in the ones/units).

Natural Numbers and Their Symbols

- This chapter contains relevant and interesting facts that you could use as warm-up discussions/activities with the students, such as explaining how I I I was a symbol (in ancient Egypt) for what we now have as the symbol 3.

- Try the suggested exercise on page 15. I know it's a bit of Monty Python and the Holy Grail here but it may have been a better choice to say "Name one thing the Sumerians have done for us" rather than the Romans. These Sumerians were on the ball when it came to numbers and maths.

Natural Numbers are Part of a Language

- This chapter once again makes for interesting and enlightening reading and I would certainly be using some of the facts presented as discussion starters with the students. The amount of writing devoted to zero is wonderful. If only the Romans (instead of the Indians) has thought of this handy little symbol! And for your students (and the wider population out there) – o is a letter not a number – zero is the word to describe 0 that you're looking for!!!

- I have used the Great Zero debate to good effect a number of times with my students. The topic is "Zero is worth nothing" and I ask for 6 volunteers (or nominate directly) – 3 for the affirmative and 3 for the negative team, and the opposing teams have to 'square off' in a debate. I allow them a couple of days to do their research and get their debating act together, and they have 3 minutes

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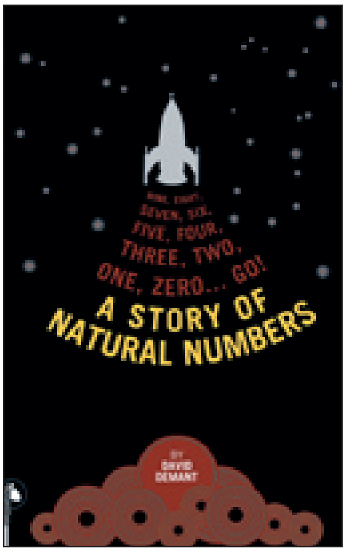
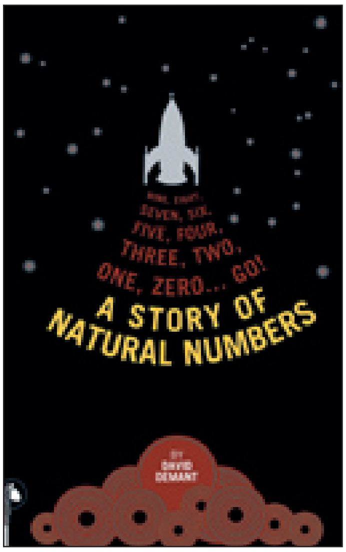


per person to state why in fact zero is a useless number/symbol/concept or why zero is crucial and should be lauded as one of the greatest inventions of all time.

- In this chapter, Demant also touches on one of the precious aspects of primary school (and any other level) mathematics – place value ('It's All About Position', p 32) and zeros role in holding a place. Leave out a zero and $5005 becomes $505 – rip off! Or, what would you rather have: 37 gummy bears or 73 gummy bears? Both numbers have the digits 3 and 7 in them. Their ultimate value all depends on what position they hold.
- Play 'Order Order' with the students. At grade 5 or 6 level the activity may look like this:
  - Divide the grade/class into mixed ability groups of 5 or 6 students
  - Use numbers such as 30 303; 30 003; 33 030; 30 330; 30 033; 33 300 and write these on cards. Give each group a set of the cards. All numbers on the cards should be derived from the same combination (in this case, threes and zeros). I always choose numbers with 2 or 3 zeros just to make it more challenging and so that students appreciate the role of zero in place value
  - Ensure there are sufficient cards so that each group member has a number. It is important that each group receives the same number of cards
  - Each group should stand in a different part of the room. Present one person in each group with their set of numbers on cards –face down. Tell the groups that on the verbal signal of "Go" the nominated person should distribute the cards so that each member has at least one card
  - The objective is to be the first group to line up the cards from smallest to largest number. Note which group finishes first, second, third, etc. Once all the groups have finished, start checking from the group that declared they finished first to the group finishing last that have, in fact, lined up the numbers from smallest to largest correctly. I have the children holding the cards do this by asking them to read out their number. You and the other students, should hear the numbers increase in value
  - After the first round, collect the groups of cards and redistribute so each group has a different set of cards
  - Other sets of numbers that could work well at grade 3 or 4 level: 5050, 5055, 5505, 5550, 5505; 8006, 8060, 8066, 8660, 8606; 6730, 6073, 6370, 6037, 6307.



– You can even use this game to reinforce/revise place value for fractions/ decimals/percentages. For example a group needs to order from smallest to largest value the following cards: ¼, 90%, .1, $^2/_3$, .5; 75%.

Number Systems

- If you have some students who may enjoy the challenge of binary numbers or working numbers with bases other than ten, then this chapter may be useful. From my experience, students get enough of a challenge with good old base10. 'Based on 10' (pp 56-57) is well put together and worth sharing with your students.

- To help with the notion of written words expressing number symbols and translating these words to numbers, you could try the following:

  – Write these words on the board: 'sixty', 'hundred', 'four', 'and', 'thousand', 'eight', 'three'

  – See how many variations the students come up with (could include numbers such as 64 803, 4 863, 83 460, 8 364, etc.)

- 'What number is not' (pp 64-65) is another really worthwhile section from which you can choose snippets to read to the students. Have the children consider and record why they believe 7 is a 'lucky' number. Maybe it's because if you roll 2 dice a seven is the most likely number to be rolled? If you can work that out you will know why seven is luckier than the numbers 2, 3, 4, 5, 6, 8, 9, 11, 12.

The Origin of Natural Numbers

- If you are able to manage the manual (and mental) dexterity required for the 'Counting with the fingers' exercise (pp 69-70), then push on to 'Why did people start using number?' (p 74) and 'Animals have their limits too' (p 75) and use these as discussion starters with your students. Paragraph two on page 74 sets an interesting challenge (bit of the old subitising) to take up with the children.

- Read 'We match things all the time' (pp 80-81) to the students and then try them on this problem. I call it 'Argy Bargy Bus Drivers' (apologies and thanks to Sullivan and Lilburn, *Open Ended Maths Activities*, Oxford). It goes like this – at my school there were 60 kids who came to school by bus each day. Some buses might have had a large number of children on the bus while another might have had only 4 or 5 kids on the bus. Now the bus drivers were paid by how many children were on their bus so there was some jealousy and general unhappiness between the drivers. To fix the problem the school council passed a rule so that every bus has to carry the same number of students. How many buses might there have been carrying the 60 students to school? Encourage the students to come up with a number of combinations (3 buses with 20 students on each, 6 buses with 10 students, 10 buses with 6 students, etc). Note the students who who produce their combinations systematically and record all possibilities.

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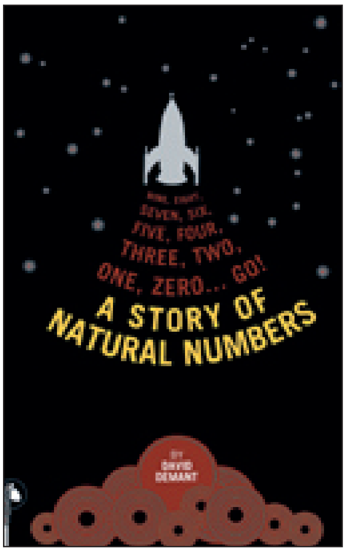

- Ask the students to order the mathematicians featured in this chapter (Albert Einstein, p 85; Srinivasa Ramanujan, p 92; Hypatia, p 97; Pierre De Format, p 99; ibn Musa Al-Khwarizmi, p 101; Mary Edwards, p 112) from earliest to most modern. As this is by no means an exhaustive list of significant mathematicians, have the students do research to find an additional three (eg. Pythagoras, Galileo, Newton, etc) to include in their timeline, and ensure they detail the contribution made by these mathematicians.

- Name one thing the Sumerians gave us. Well, there's summer for a start! Maybe not, but challenge the students to work out how the symbols on page 96 work. How would 60 000 or 72 000 look Sumerianally speaking?

- 'The birth of our natural numbers' (p 100) and 'Decimal number systems take over the world (pp 101-104) are well worth a read (to the students). Perhaps explain why the Roman Empire fell – too busy writing out complicated numbers (try p 106 with the students) while the Huns were looking for a bit of Rome to knock over! If only they had a zero (see debate activity above) and knew place value. Write out the number of the 2008 Olympic Games in Roman numerals.

- Read 'The final clincher' (pp 108-109) to the students and then ask the students to identify some other numbers that are 'big factor' numbers (it has to have more than six factors to qualify). Start with a number, such as 60, and have students ask you questions whose answer is '60'. For example, how many minutes are there in an hour? how many eggs in 5 dozen? what number has 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 and 60 as factors? What number did the Sumerians use as a base?

- Get some opinions on Demant's conclusion on page 118. What do you think? Why?

Things To Think About When You Have A Spare Moment

- The final chapter has some good challenges and activities for the students to try.

- Why is the symbol for infinity (an 8 lying on its side) a pretty good choice? Explain. Answers might include that when you draw/write the symbol for eight your pen could feasibly never come to an end like the other numbers – there's no cliff or hill that designates an end point. Wouldn't zero have worked just as well?

- Do the 'Hotel Infinity' exercise (p 123) with the students.

- When I work with the younger grades I have the students determine whether a number is odd or even by drawing the number of dots it would represent, much like they would draw an array. For example: 6 = * * *
          * * *

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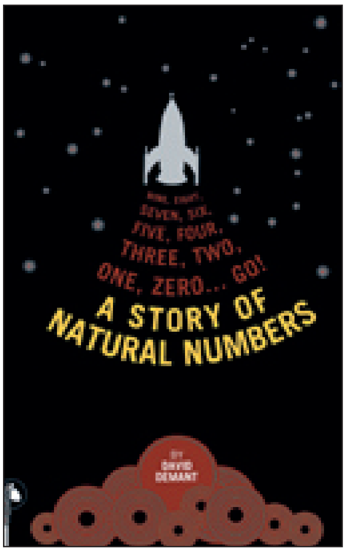

  - Now I have the children draw a line from the dot on top to the dot immediately below and say "has a partner". Do the same for the next pair of dots. Start at the top dot and draw a line to the dot underneath while saying "has a partner". Do the same for the last two dots. Every dot has a partner so must be even. For 7, draw

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    * * * *
    * * *
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  - Do as for 6. When the children reach the dot (the seventh) at the top and attempt to draw a line from the top to the bottom dot they realise there is no bottom dot - "doesn't have a partner". Obvious conclusion – must be odd. Try it – it works.

- What are some other 'Perfect numbers' (p 125)?
- Is there really no billion (p 126)? Surely we need something between a million (six zeroes) and a trillion (twelve zeroes)?
- Try some of the exercises as suggested on page 127, or if too difficult try some challenges such as: "If a million is 1 000 000, try writing a trillion".
- What is 111 111 111 x 111 111 111? (answer is 12345678987654321). Let the students use their calculators and encourage stratgies such as solving a simpler related problem (eg. 11 111 x 11 111), identify a pattern, write a number sentence or guess and check. Try sorting it out (comma or space after every third number starting from the right) and then saying it!

Ahh numbers! The best thing about them is that they are just there to help us make sense of the world.

About David Demant

David Demant is a science and technology communicator with an interest in the history of information and communication technology. He has written and contributed to a number of informational books for children. David was manager of education and visitor programs at Scienceworks, which he helped develop. He participated in the development of Melbourne Museum. David believes that storytelling is the most effective form of communication in museums... and everywhere else.

About the author of these teachers notes

Rob Vingerhoets is an experienced educator who has recently worked with teachers and students in New York City. Prior to this he was a primary school principal, curriculum coordinator and classroom teacher. He is an experienced teacher and author, having written a number of best-selling maths resource books and numerous articles.

Rob is a popular and engaging presenter of hands-on and engaging maths ideas and