Making words work to support mathematical understanding and reasoning

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Objectives

This workshop is designed to:

- Support delegates in ensuring speaking and listening has a high profile within the mathematics curriculum, being used to challenge and stimulate thinking and reasoning skills.
- Share effective engagement strategies and practical language-based activities to scaffold, develop and extend children as articulate and independent mathematicians.
- Give staff a greater awareness of how to make the maths curriculum more accessible and engaging for EAL learners.

Aims of the mathematics curriculum

- become **fluent** in the fundamentals of mathematics - develop c*onceptual understanding;* varied/frequent practice with increasingly complex problems over time; able to recall and apply knowledge rapidly and accurately to problems
- **reason mathematically** – follow lines of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language
- **solve problems** – apply mathematics to a variety of routine and non-routine problems; increasing sophistication; breaking down problems into simpler steps ; persevering in seeking solutions

Mathematics

- 3 areas of vocabulary to consider:
- **Subject specific**
- square, triangle, number, three, add,
- **General but subject specific**
- order, take-away, light, watch, hands, face
- **Academic vocabulary related to logic, logical conclusions, possibility etc.**
- If ….. then…..because …….must be …..can't be …..could be ..therefore ..the language of comparison (bigger, biggest etc.)

Types of talk

- Argument
- Comparison
- Deduction
- Description
- Evaluation
- Explanation
- Hypothesis
- Opinion
- Predicting
- Retelling
- Sequencing
- Summarising

Language Functions
Language Structures
predicting
could (n't)
should (n't)
ought (not)
you can see that
must
justifying
does not….. because
my reason is
is a….because
classifying
this is the odd one out because
these are all
this fits here because
these are not
positioning
anti/clockwise
left/right
on/in/under/next to
compass points
describing
this…..is….but the…. is……
a little bit
more/less
the same
different
qualifying
always
sometimes
perhaps
never
probably
Hypothesising
even chance
would it work if we…?
I think it might be..
likely/unlikely
comparing
bigger/smaller
regular/irregular
most/least popular
exploring
what would happen if?...
what if we…
lets try
what if we…….
this information is important
explaining
it works by
because
when…then….
reporting
I decided
it's like this
sequencing
before
next
last
in between
ordering
first
second….
this is what you do
checking
I know it was right because
next time we could
I know it was wrong because
estimating
nearly
close to
approximately
rounding
to find the answer you would

Talk frames

- Talk structures need to be modelled and given to pupils to enable them to verbalise their thinking and learning.
- *Speaking frames* provide models of sentence construction, language structures, and vocabulary for learners to use orally within a curriculum context.

Speaking and writing frames

- **Sentence starters** are useful for example in practical subjects when learners are asked to evaluate a project they have taken part in, and say, or write, what they have learnt from the experience. *'I learnt that …' 'One thing I discovered was …', 'I found out that …'*
- **Sentence frames** are helpful when asking learners to organise their thoughts in a particular way, e.g. justifying their answer*: 'I know that this is a _____ because it has ___ corners and __ angles.*

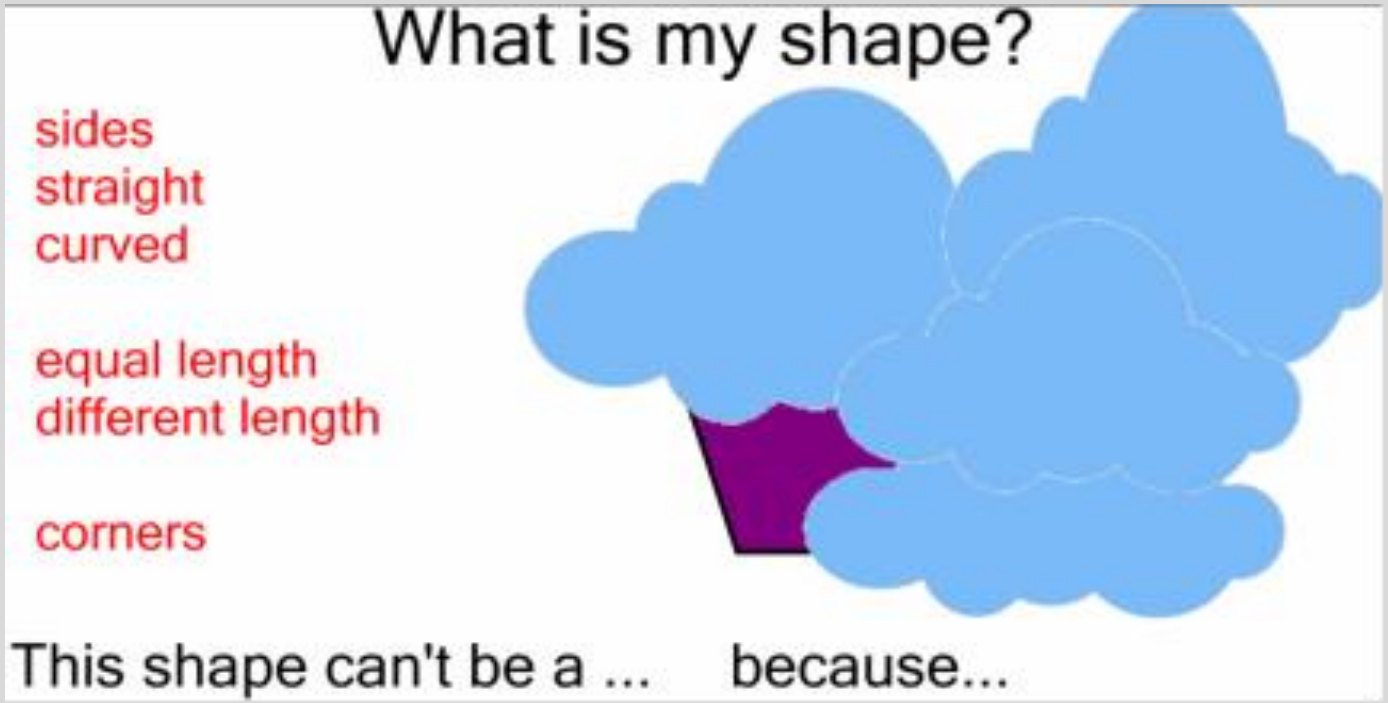
Talk Frame for reasoning

- I agree with…because
- It might be/ It could be…because…
- I disagree with… because
- **It couldn’t be…because…**
- In my opinion/ I think it must be…because
- I’ve changed my mind….

Talk Frame for Reporting Back

- I / we worked with...
- I / we did...
- First of all …
- After that…
- *Next…*
- Finally…
- The problems were …
- I / we solved the problem by …
- I / we knew that the answer had to be bigger than …

Talk frames

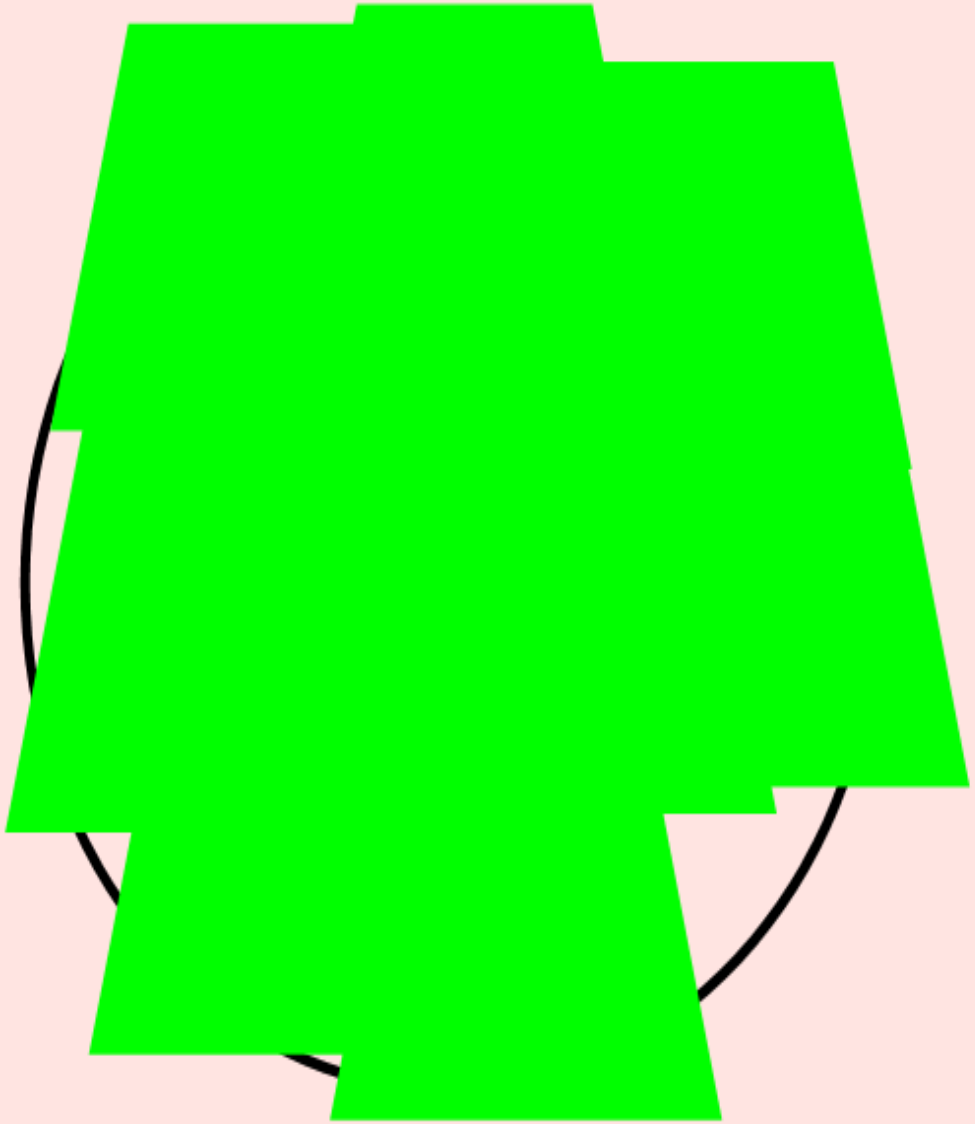


Model: This shape could be a triangle because I can see 2 straight lines and one angle. It is possible that there is another straight line linked to those 2 lines to make a triangle. It could also be a ____ because it is possible there are___ more straight lines to complete this shape.

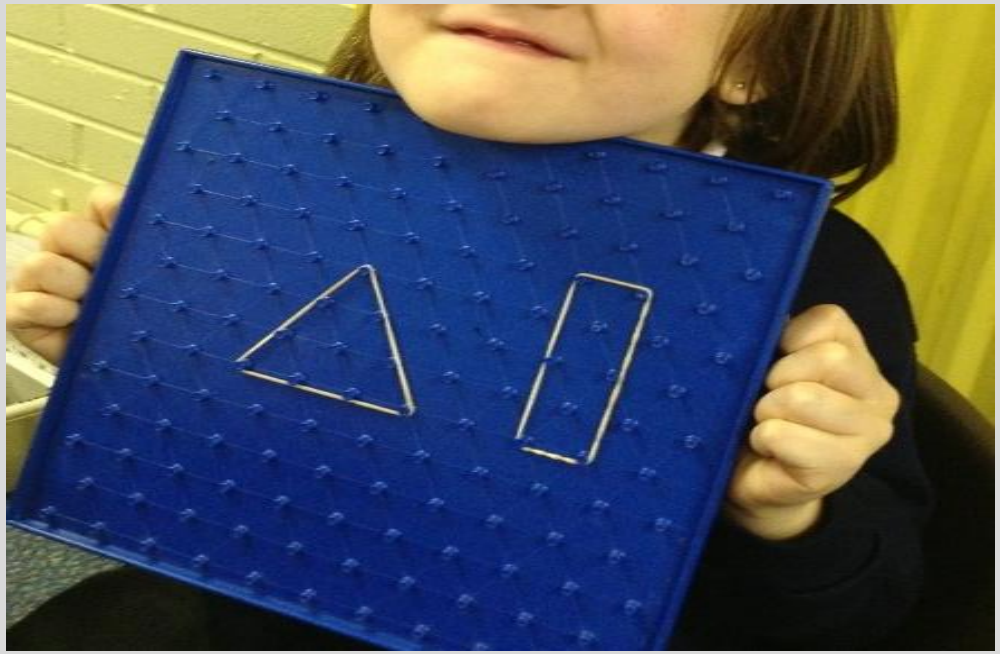
This shape couldn't be a _____because……..

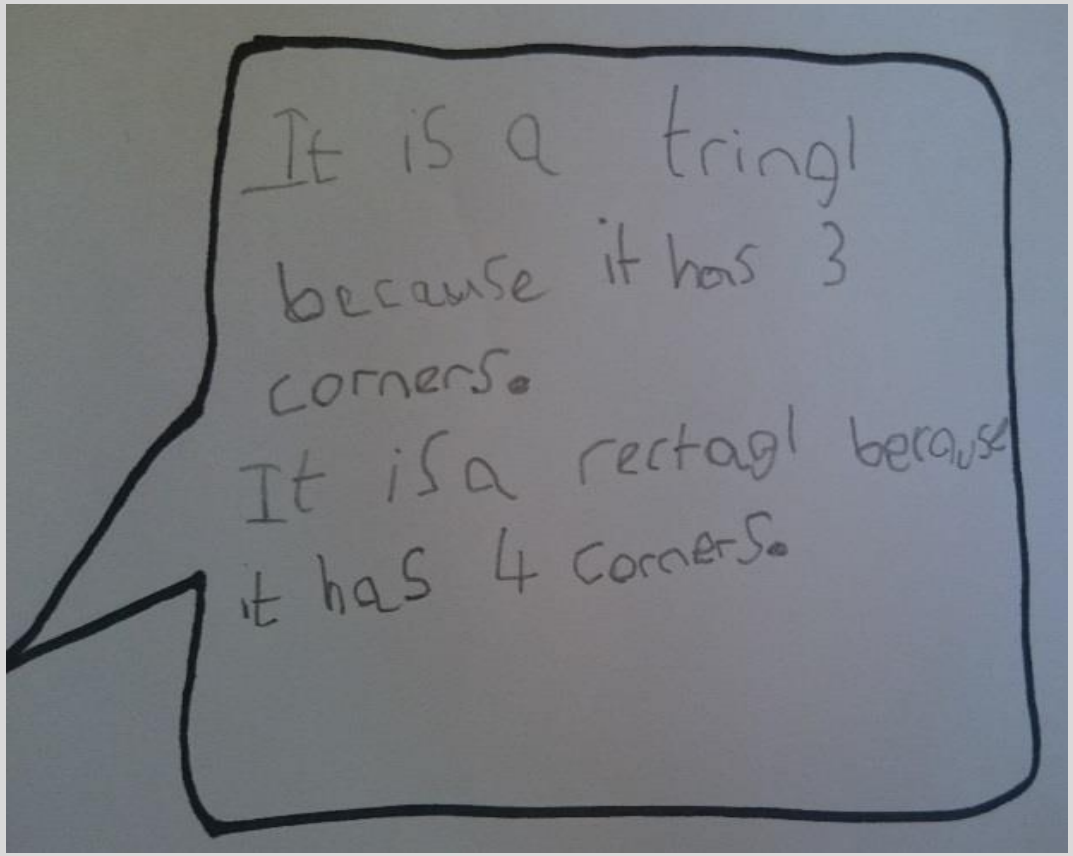
It is a ... because...

It is a Circle because it is round.



Sentence Stems



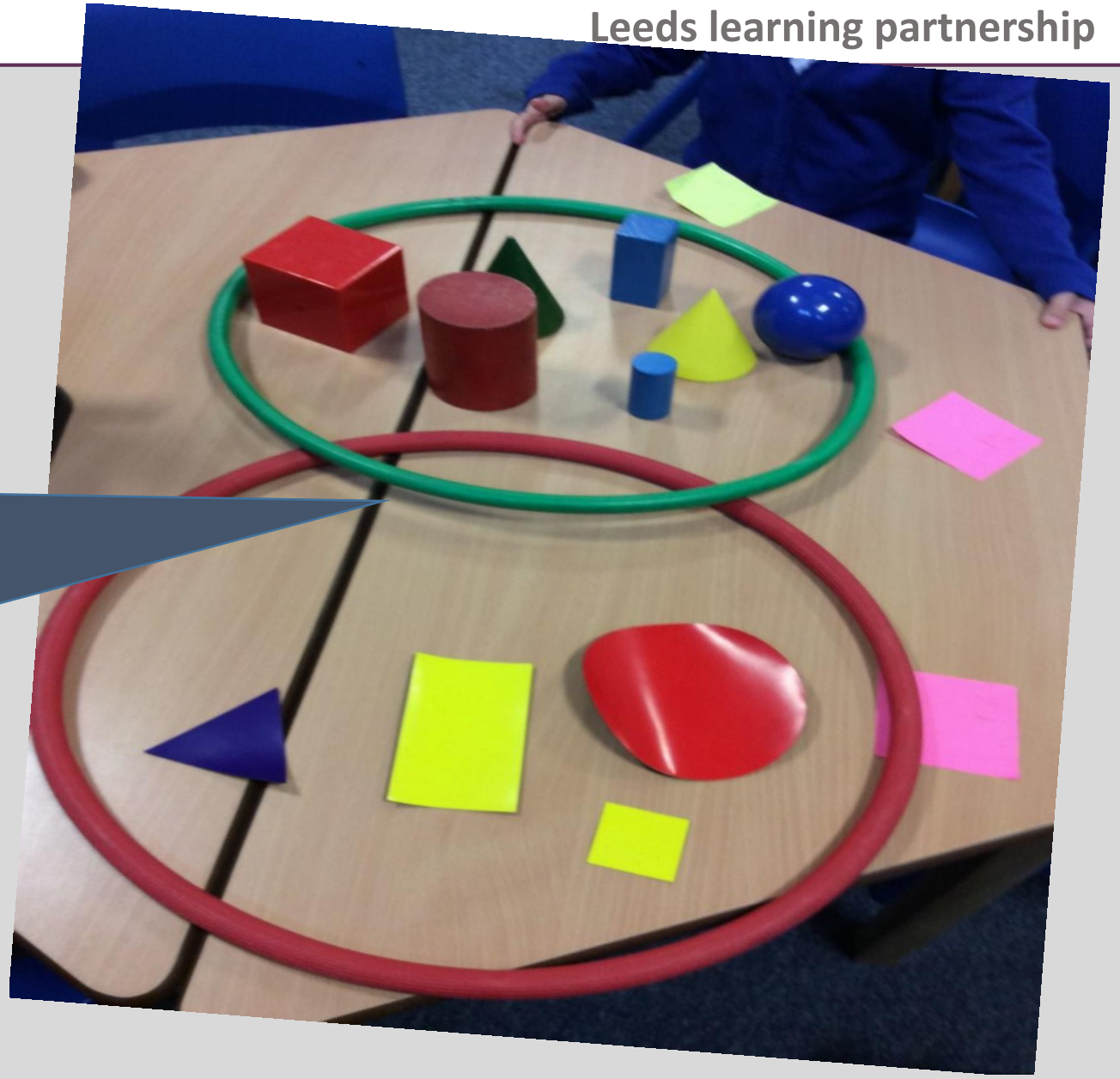


These helped the children to use the vocabulary in context

Sentence Stems

I know it is a cylinder because it has 2 circle faces.

I know it's not a cone because it has no vertices



WALT: Recognise coins and their value. ✓ (I) 24.3.15

The children were introduced to the different coins that we use in England and we named each one. They then worked in mixed ability pairs to identify the features of each coin. As a group they then presented their work to the rest of the class. We looked at similarities and differences between the coins and talked about how we could tell which was which.

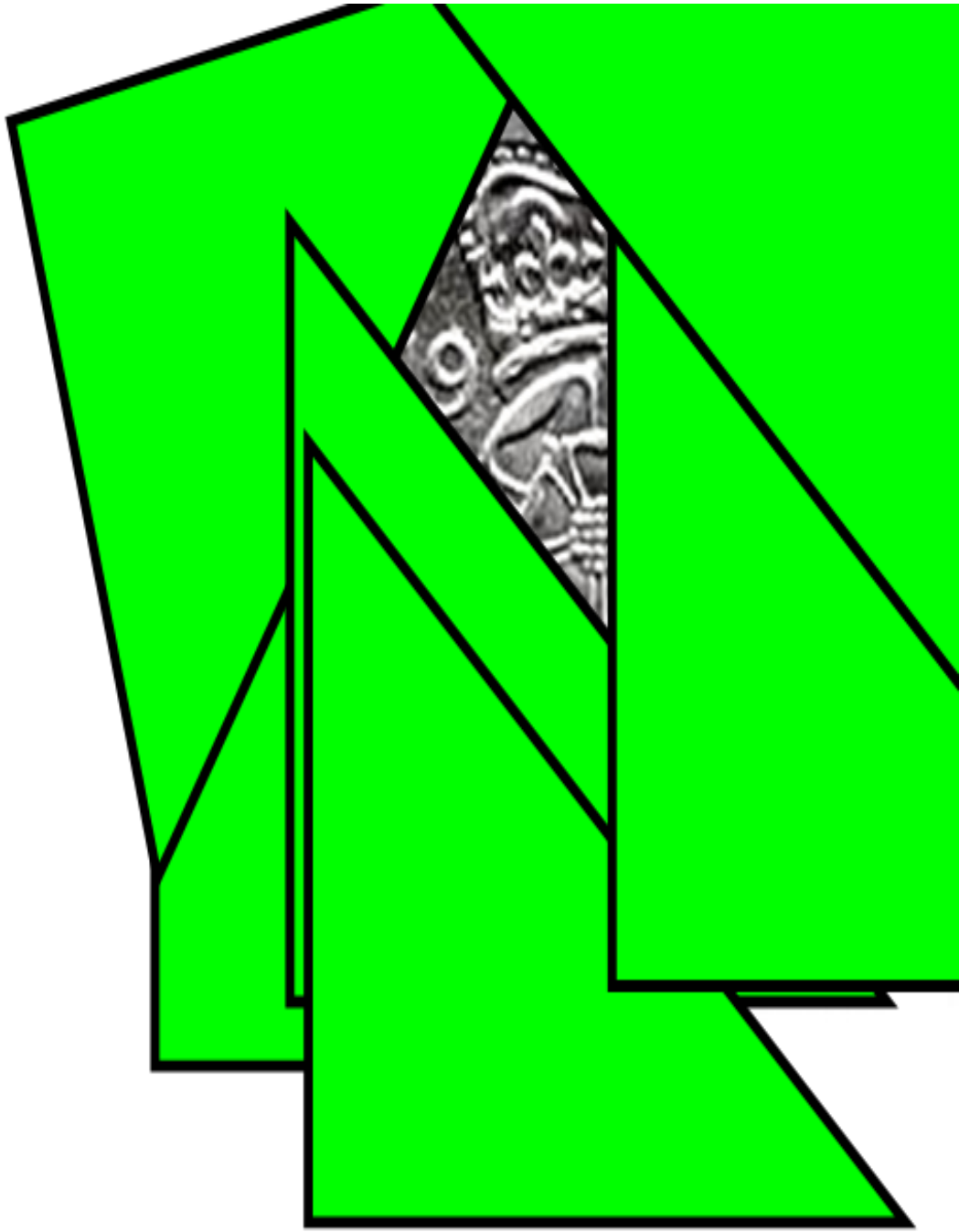
To encourage the children to use the correct vocabulary we used a talk frame:

It is a ... because...

It isn't a ... because...

This coin is a ... because...

It isn't a ... because...



it is 2op because it silvr and i can see a crawn

Our Reasoning Rich Classroom

maths

I noticed that ...

I already knew ...

It won't work because ...

It must be ... because ...

It could be ... because ...

It can't be ... because ...

I looked for ... pattern/rule/sequence/relationship

I tried ... and this happened ...

If ... then ...

I noticed that 1 pair of knee socks + 3 pairs of ankle socks = £12.95
5.45 + 7.50 = 12.95

If she spent £12.95 then she got £7.05 change.

£8.50 × 3 = £25.50
3 × 5 pairs = 15 pairs

£20.00 − £12.95
To column or not?
12.95 → 13.00 (+0.05) → 20.00 (+7.00)
20.00 − 12.95 = 07.05
Which is more efficient?

8.50
8.50
8.50
25.50
I tried adding lots of 8.50 until I got to 25.50

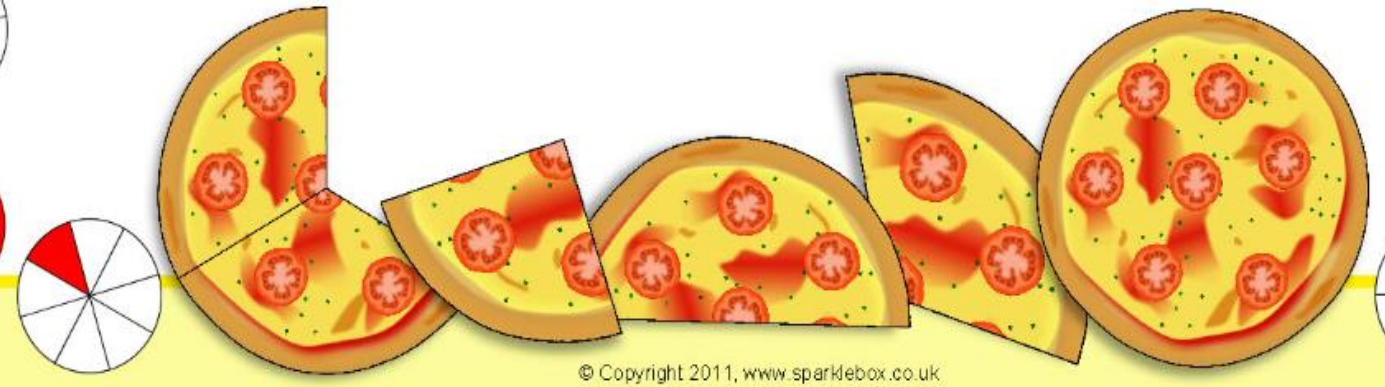
It can't be 3 because it says 5 pairs = £8.50 and she spent £25.50.

millions	hundred thousands	ten thousands	thousands	hundreds	tens	ones	tenths	hundredths	thousandths
1 000 000	100 000	10 000	1 000	100	10	1	0.1	0.01	0.001

This fraction is a _____ because .....

This fraction isn't a _____ because .....

part, equal part, one whole, half, quarter, third



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The Primary Mastery Professional Development materials

- https://www.ncetm.org.uk/resources/50640

- *"I thought the oracy side of those spines was really strong and really clear. Sometimes one of the trickiest things to do when planning a lesson is to think 'OK, how many different ways can you say this?' And of course you go into depth with the vocabulary, but you're given stem sentences that you can link across other areas." (Year 6 teacher)*

The Primary Mastery Professional Development materials

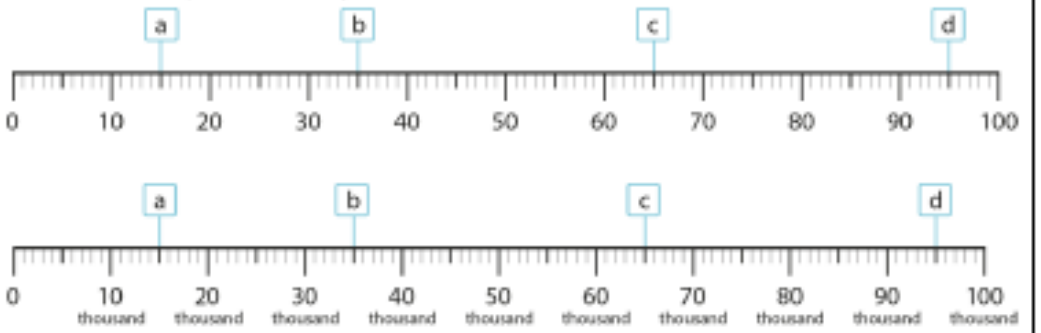
- *"Some of the best lessons we had out of the spine focused on the oracy point, where, for example, the whole class practice you would fill in the 7 times tables, using prior knowledge. So the stem sentence was 'I know from my ___ times table that ___ times ___ is ___.' And that helps to create that link. There's that classic thing that children find tricky, is that duality between the tables – 3 times 7 is 21, but so is 7 times 3. And just by saying it, it starts to cement that." (Year 3 teacher)*

The Primary Mastery Professional Development materials

Teaching point 2:

Multiples of 1,000 up to 1,000,000 can be placed in the linear number system by drawing on knowledge of the place of numbers up to 1,000 in the linear number system.

Steps in learning

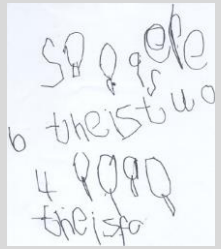
	Guidance	Representations
2:1	Now move on to locating the ordinal position of numbers in the number system and identifying numbers marked on a number line. In segment *1.22 Composition and calculation: 1,000 and four-digit numbers*, children unitised to link what they know about three-digit numbers to four-digit numbers. Again in this teaching point, focus on building direct links from children's knowledge of two- and three-digit numbers to five- and six-digit numbers. The aim is to avoid common errors, like marking the midpoint of 10,000 and 20,000 as 10,005 or 10,500. Start by displaying the 0–100 number line, shown below. Identifying the numbers located at the small tick marks is a skill that will be deeply embedded by now. Draw arrows or boxes pointing to some numbers, as below, and ask children to explain how they can identify what these are. Once you have checked they can do this confidently, look at the second (unitised) number line shown below. Discuss the value of each of the labelled intervals (*'10 thousand'*) and each of the smaller unlabelled intervals (*'1 thousand'*). Explicitly make the link back to the previous number line and ask children to identify the numbers shown by the boxes, using the following stem sentence to structure their answers: ***'The midpoint of ___ and ___ is ___, so the midpoint of ___ thousand and ___ thousand is ___ thousand.'*** Once the children can work with the middle 'unitised' number line and verbally identify the midpoints, introduce the final number line shown below. As a class, count up in 10,000s, pointing to the digits as you go, to reinforce the connection between the three number lines; children should be quite confident counting up in 10,000s from *Teaching point 1*. Ask them to identify the same midpoints marked by the boxes, again linking to the previous two number lines. This time, make sure that the children are able to write the midpoints in numerals (e.g. *'15,000'*) as well as say them in words (for example *'fifteen thousand'*).	Number lines: *'What are the midpoints shown by a–d?'* 

Making Connections

leads to secure understanding - the ability to manipulate and 'play' with number and other concepts

Symbols

Language

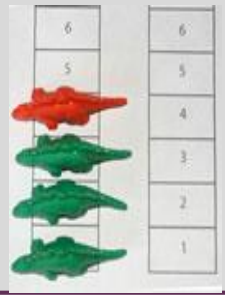


Pictures,

Images,

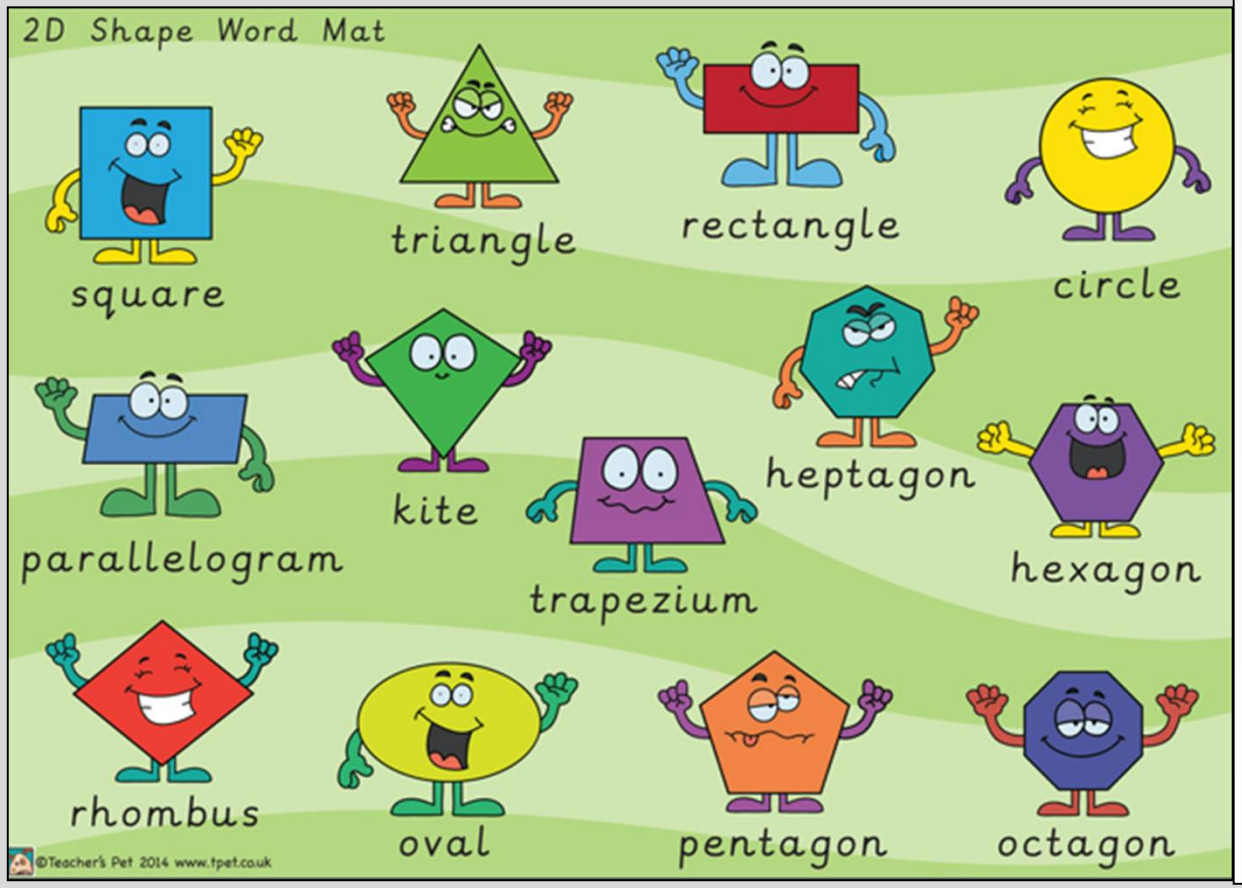
visualisation

Concrete experiences



Connections model from Haylock and Cockburn

Word mats


2D Shape Word Mat
square
triangle
rectangle
circle
parallelogram
kite
heptagon
trapezium
hexagon
rhombus
oval
pentagon
octagon
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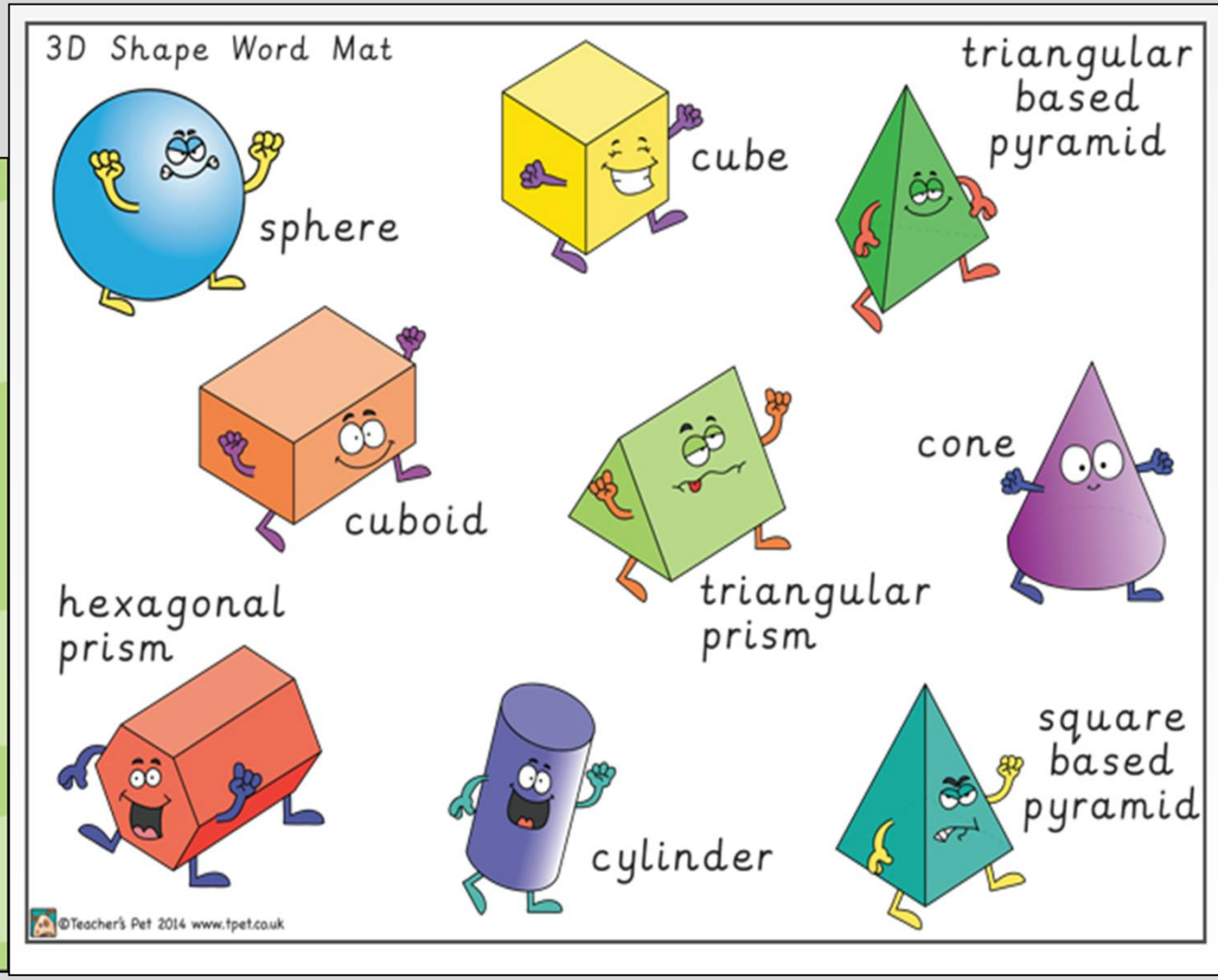
3D Shape Word Mat
sphere
cube
triangular based pyramid
cuboid
cone
hexagonal prism
triangular prism
cylinder
square based pyramid
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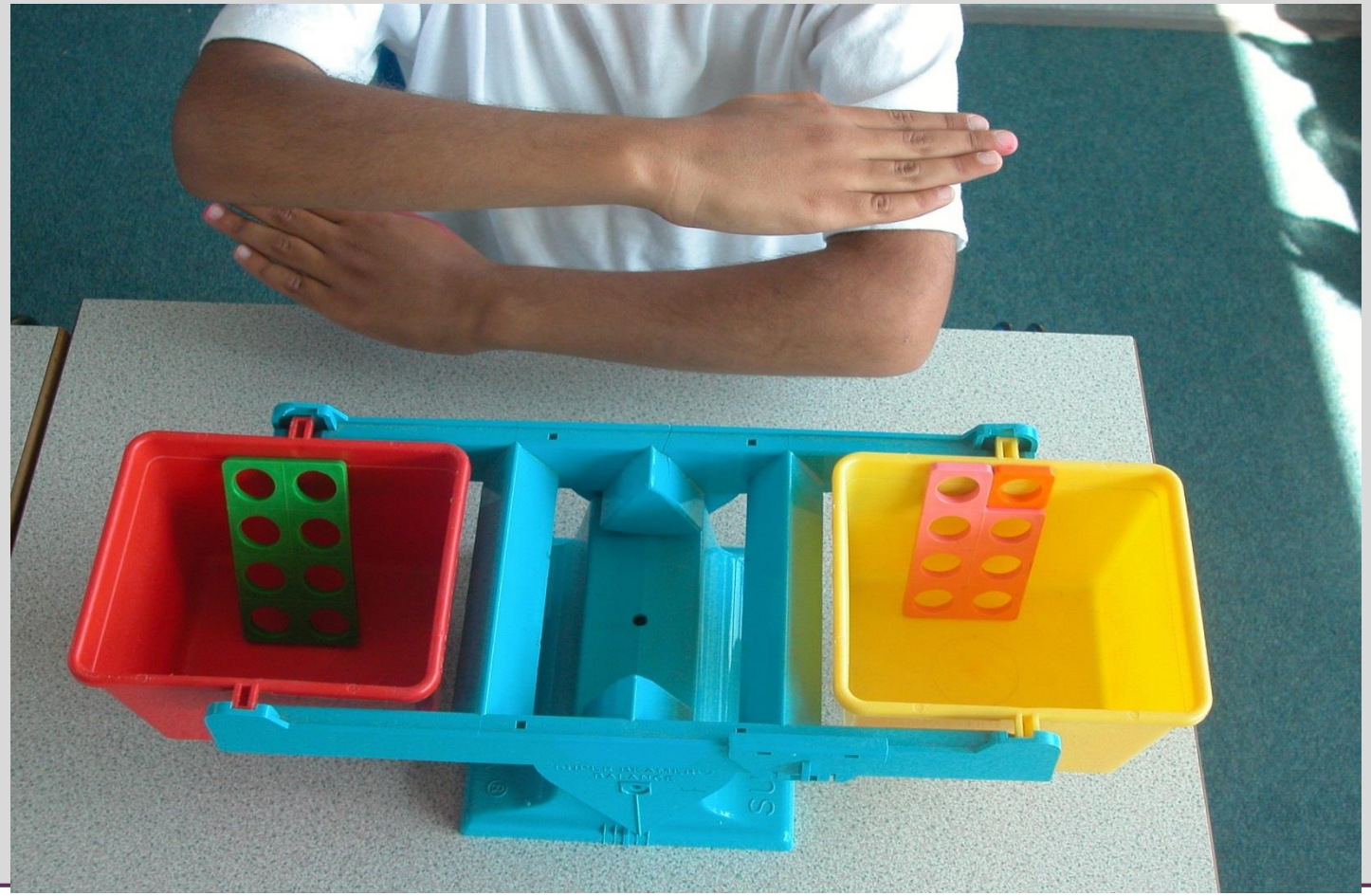
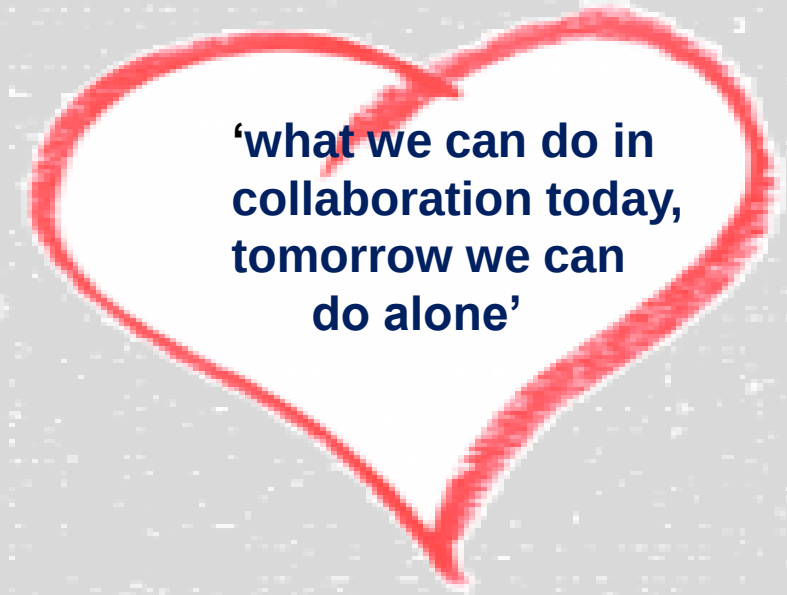
Equivalence – looks different but is of equal value





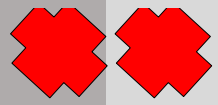
'Learning is a social process and children learn from each other as well as from adults: language - especially spoken language - is what animates this process;.....

Robin Alexander

Collaborative maths activities

- Word Studies
- Vote with your feet
- Odd one out
- Agree / Disagree
- 60 Seconds
- Talk Partners
- Think, Pair, Square, Share
- Stem Sentences
- Explaining of models and diagrams
- Books / Stories

Vote with your feet



Strongly Disagree

Disagree

- I will give you a statement
- You have to decide if you Agree, Strongly Agree or if you Disagree, Strongly Disagree
- Take 10 seconds to think about the statement

Strongly Agree

Agree

- Go and stand underneath the sign that best describes how you feel about the statement.
- You will be asked to express your opinion so make sure you have thought about why you think that way!

Opinions please!

- Doubling a number gives a higher number

Vote with your feet

- In my opinion doubling a number will…… for example….
- I disagree. I think that doubling a number will ……because…….
- I strongly believe that ……because……
- On the other hand ……therefore

Word studies

- A useful way to explore key vocabulary in depth
- Incorporating visual, auditory and kinaesthetic approaches
- Focus on category, meaning, and sentence level
- Collaborative

Objects:

What the number looks like:

11

11

11

11

Eleven

Numicon:

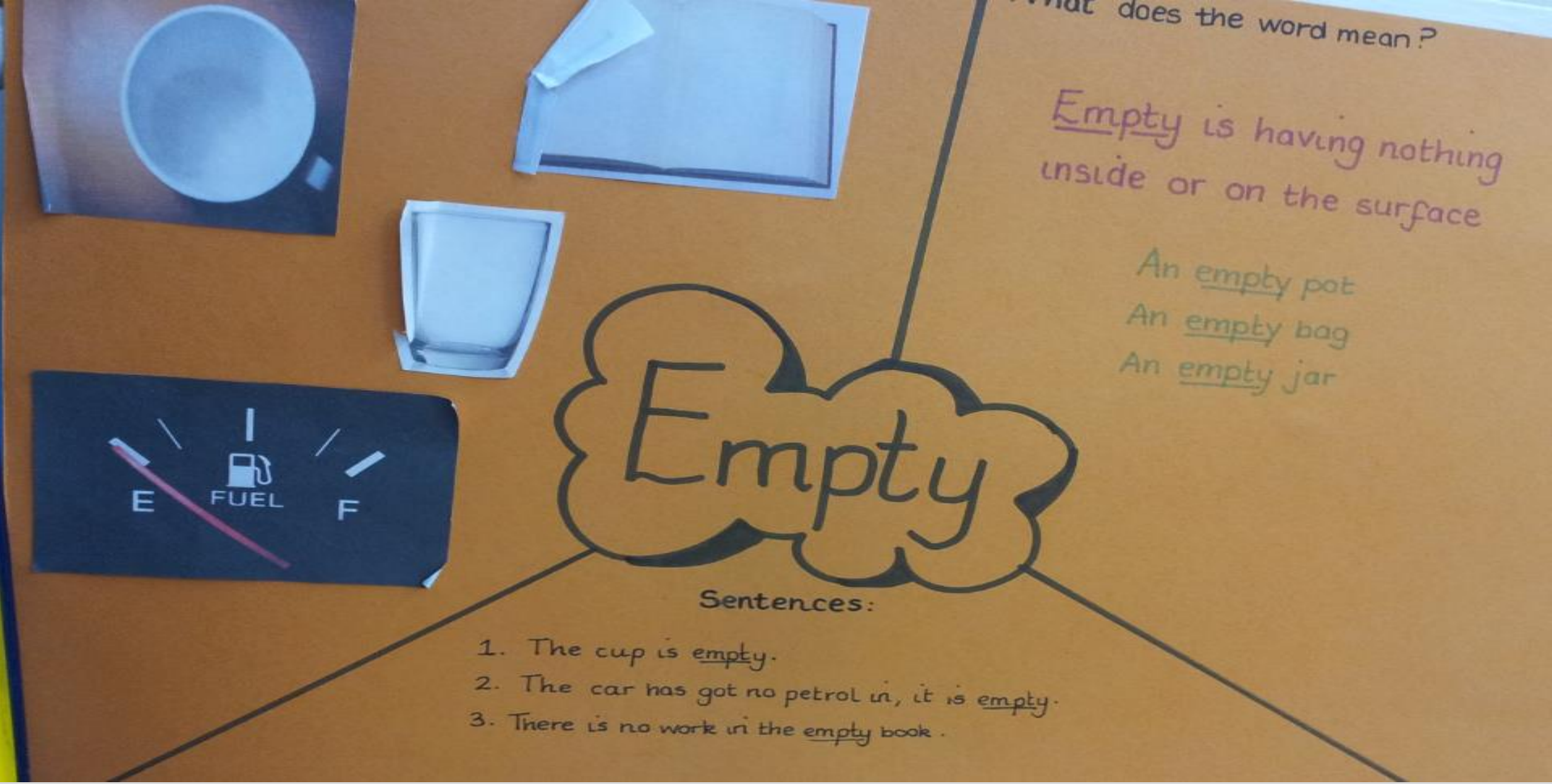
The Number Word:

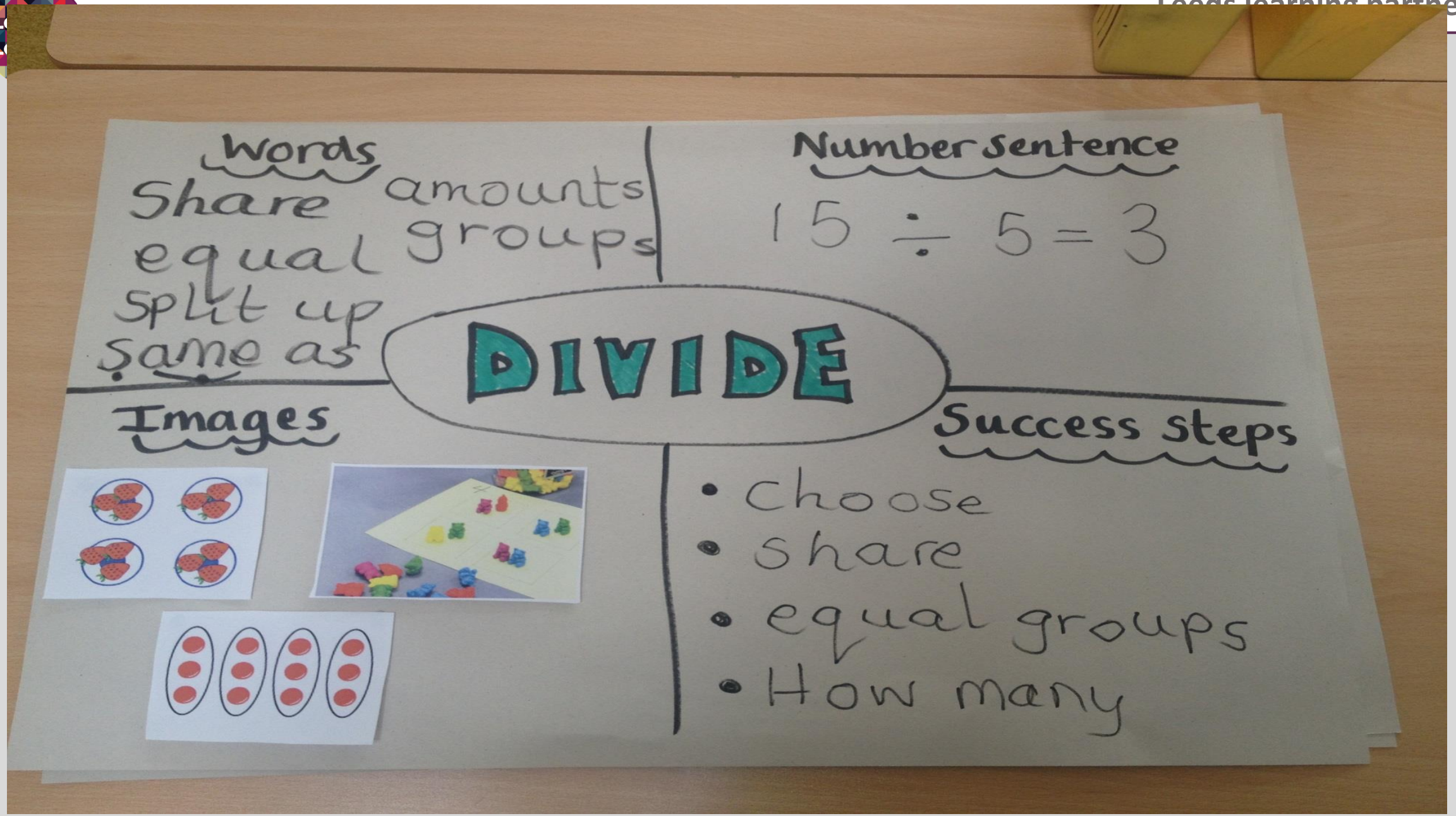
Eleven

eleven

ELEVEN

eleven


What does the word mean?
Empty is having nothing inside or on the surface
An empty pot
An empty bag
An empty jar
Empty
E
FUEL
F
Sentences:
1. The cup is empty.
2. The car has got no petrol in, it is empty.
3. There is no work in the empty book.


Words
Share
equal
split up
same as
amounts
groups
Number sentence
15 ÷ 5 = 3
DIVIDE
Images
Success steps
• Choose
• share
• equal groups
• How many

Negotiating meaning of vocabulary

Select one of the following words or phrases: quadrilateral, three quarters, multiple, century, right angle, difference. Talk in your group about what your word or phrase means and work together to agree the best way to complete each section of this poster.

Where do you see this word in everyday life?

In maths books
A quad bike has four wheels
A quadrangle in a building is an inner square or rectangular shaped courtyard.

Mathematical symbols (if there are any):

Describe what your word or phrase means:

A quadrilateral is a flat shape with four straight sides and four corners.

Mathematical word or phrase

quadrilateral

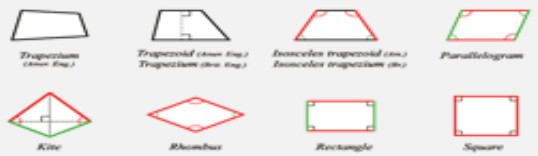
What other mathematical words is it related to?

Quad relates to 4
Lateral is a word for sides
A quadrant is a ¼ of a circle
Paralellograms are also quadrilaterals.

Use your word or phrase in a statement:

A square and a rectangle are both quadrilateral shapes because they have four straight sides and four corners.

Picture or diagram:



spherical

Make a list of things which are spherical:

- Ball
- Planets
- Beads
- Some lampshades

Syllables	Word class
3	adjective

Describe what your word or phrase means:

An object is spherical if it is round in shape.

Synonyms

round, ball-shaped, like a sphere, curved, globular

Use your word or phrase in a sentence:

Many years ago people thought the earth was flat but now we know that the earth is spherical.

Picture:

Mathematical word or phrase

circumference

Where do you see this word in everyday life?

In maths books

Measuring a circular room or space

Word class: Noun

Syllables: 5

Describe what your word or phrase means:

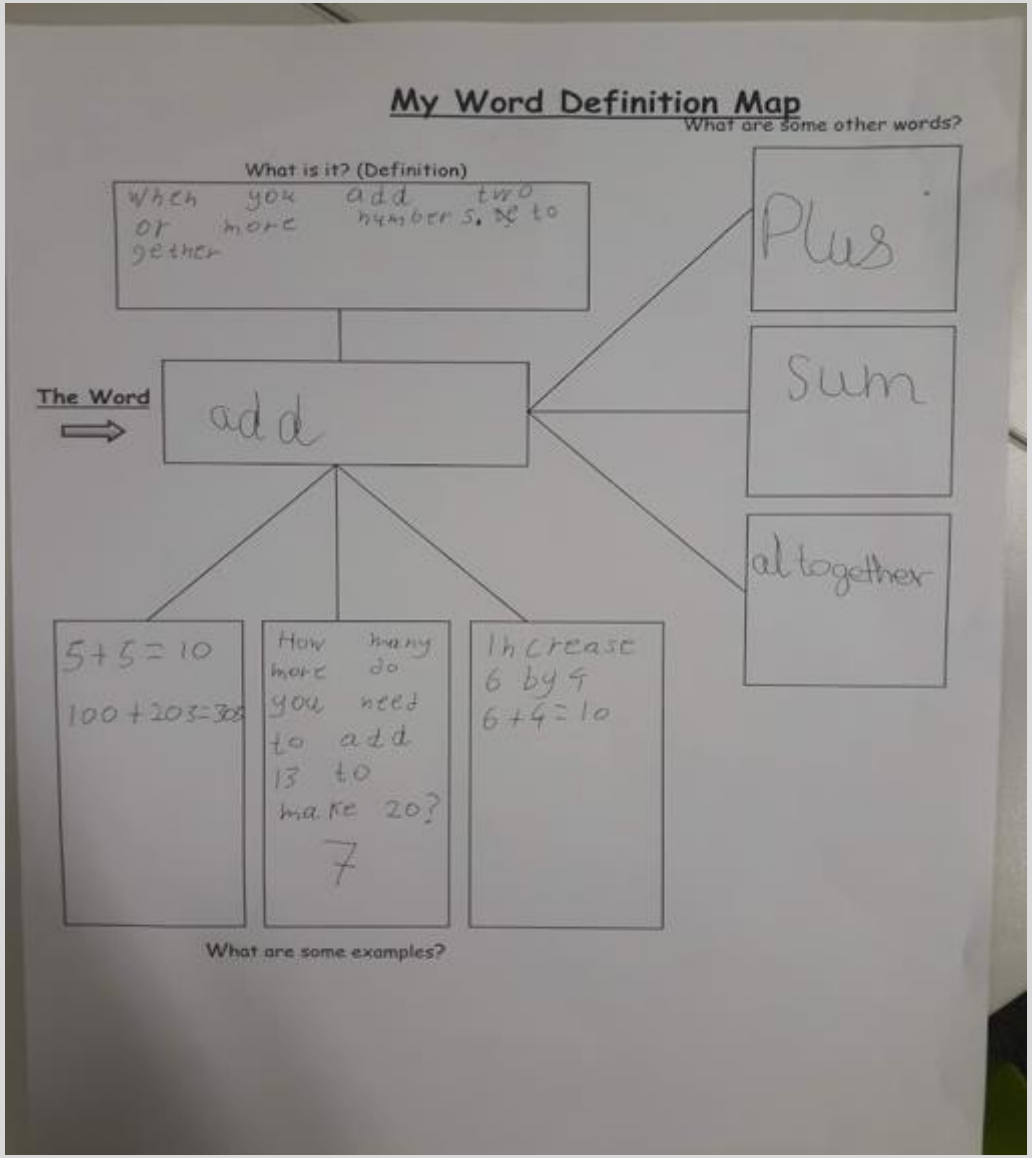
The distance around the edge of a circle (or any curvy shape).

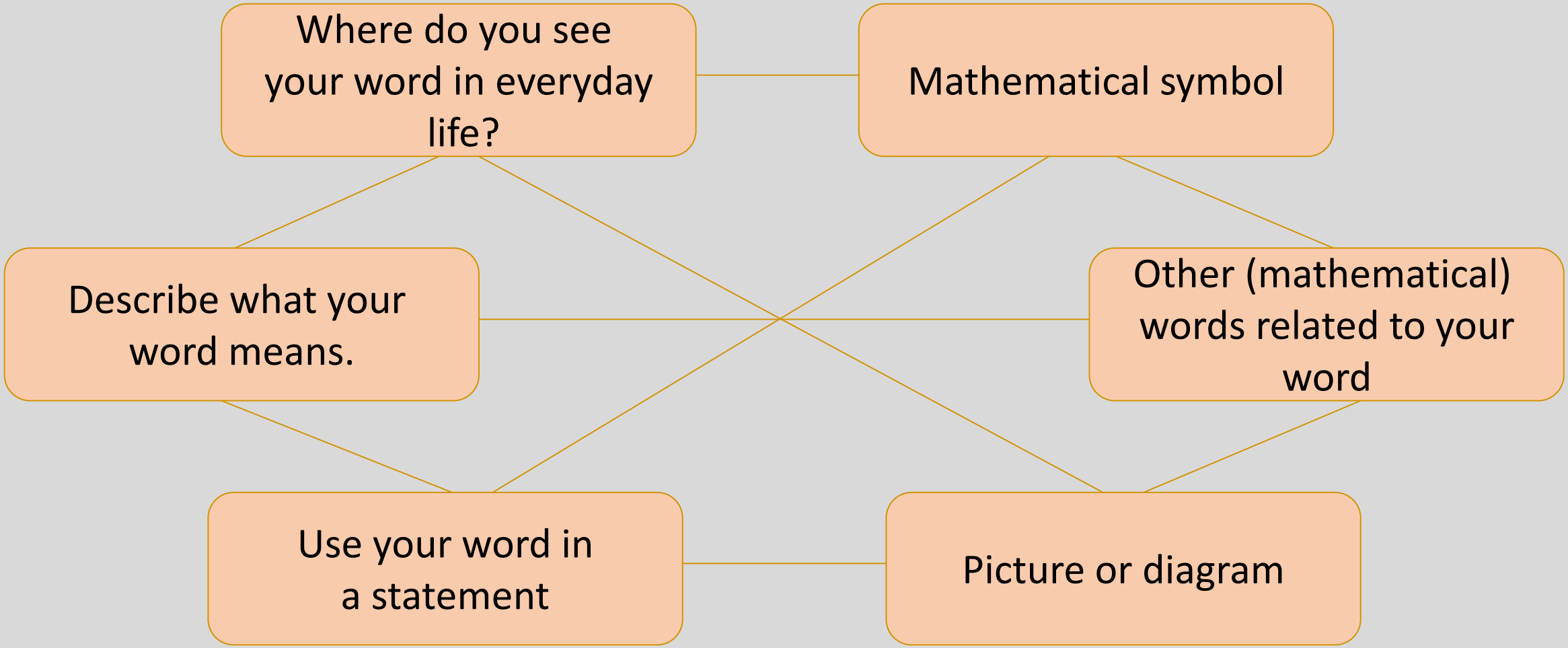
Interesting fact: The African Baobab tree's circumference can reach 55m. If the trunk is hollow, 20 people would be able to fit inside

of it.

Use your word or phrase in a statement:

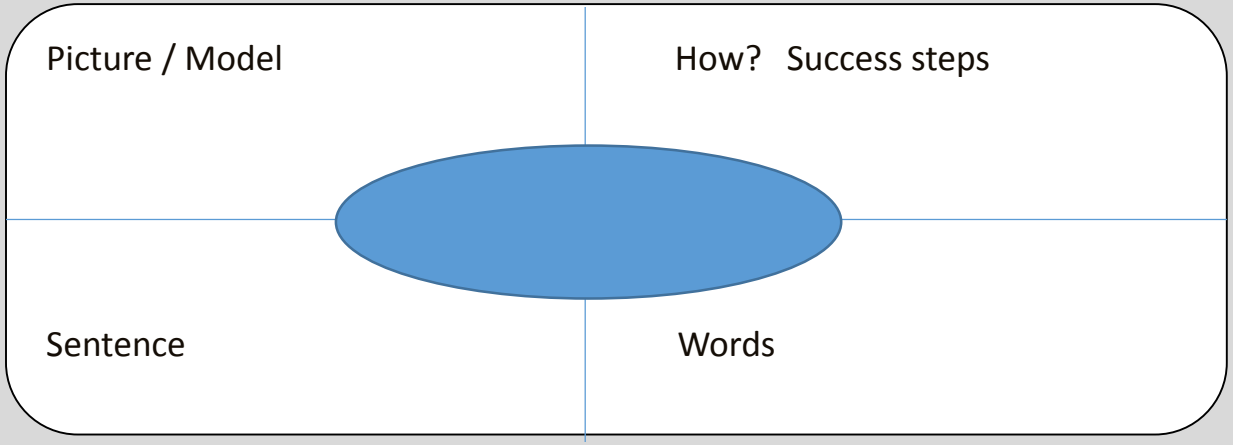
If you walk around a circle which has a diameter of 100m, you will have walked 314m because the circumference of a circle is the diameter x 3.14 (π).

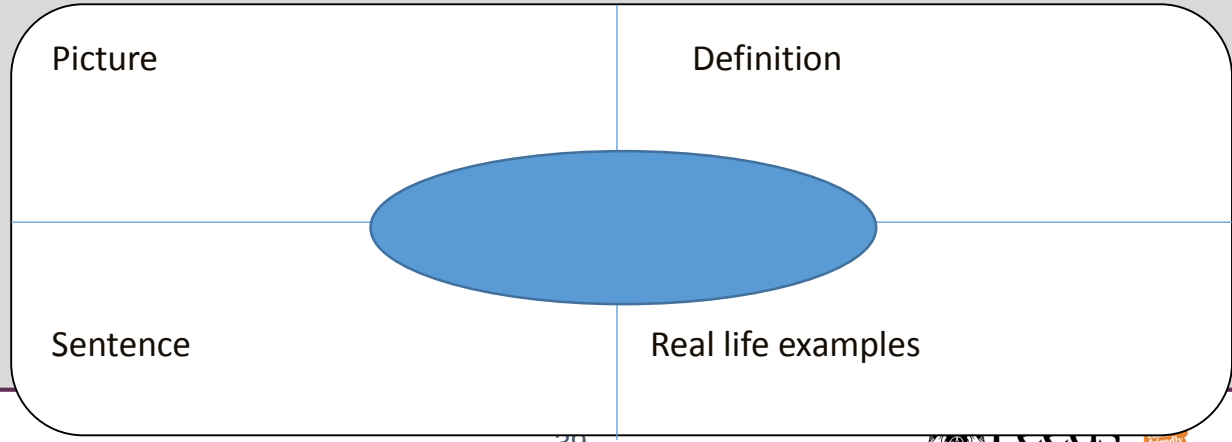

My Word Definition Map
What are some other words?
What is it? (Definition)
When you add two or more numbers together
Plus
Sum
altogether
The Word
add
5+5=10
100+203=303
How many more do you need to add 13 to make 20?
7
Increase 6 by 4
6+4=10
What are some examples?


Where do you see your word in everyday life?
Mathematical symbol
Describe what your word means.
Other (mathematical) words related to your word
Use your word in a statement
Picture or diagram

Word study task

- Think of an objective you will cover this week or next week in maths
- Decide on the vocabulary that will be relevant to this objective or topic
- Decide on an unfamiliar or challenging tier 2 word and complete a word study for it





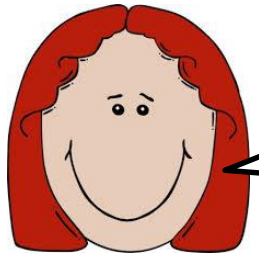
Word Study task

Concept mats in mathematics

- Exploring misconceptions
- Promoting discussion, reasoning and problem solving
- Versatile

Concept mat – Reception

LO: To describe the size of objects



The horse is taller than the dog

Ellie

The dog is taller than the horse

Jack

They are the same height

Sohaib

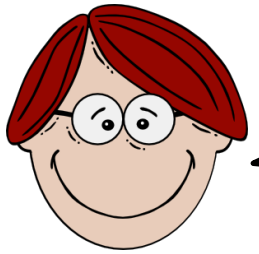
I know _____ is right because_____

I know _____ isn't right because_____

height, size, taller, shorter,

Concept mat – Year 1

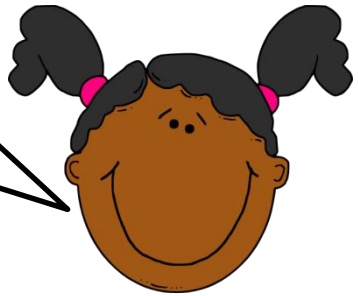
LO: To tell the time to the hour and half past



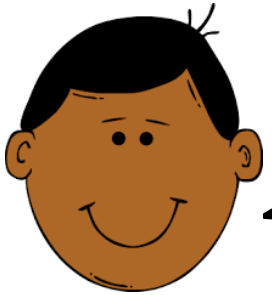
The clock shows 12 O'clock

Sarah

The clock says half past 3



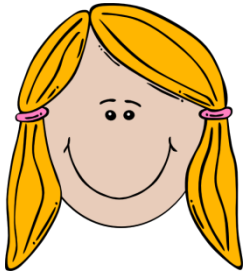
Tanesha



The clock says 3 O'clock

Aamir

The clock shows half past 12



Emma

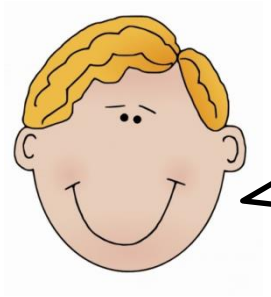
I know _____ is right because_____

I know _____ isn't right because_____

clock, minute hand, hour hand, pointing, o'clock, half past

Concept mat – Year 2

LO: To recognise $\frac{1}{4}$ of a shape

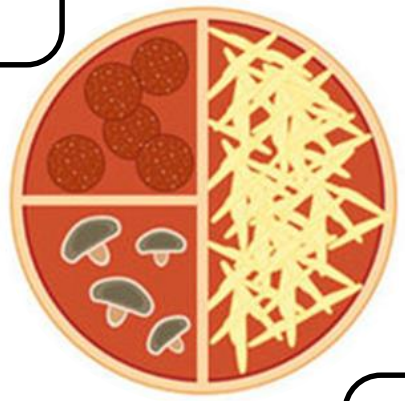


One quarter of the pizza is cheese

Sam

One quarter of the pizza is mushrooms

Olivia



Three quarters of the pizza is cheese

Abdul

Half of the pizza is pepperoni

Harry

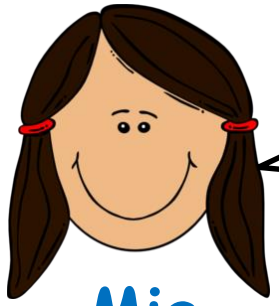
I know _____ is right because_____

I know _____ isn't right because_____

part, equal part, one whole, half, quarter,

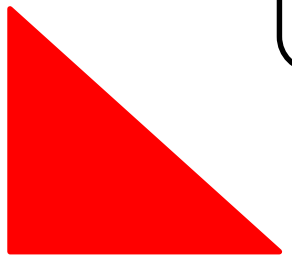
Concept mat – Year 3

LO: To identify angles in a shape

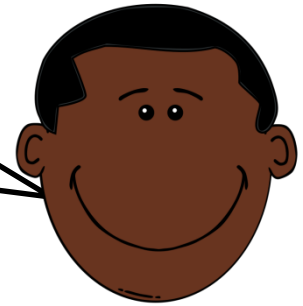


The triangle has 1 right angle

Mia



The triangle has 2 right angles



Rahim

I can see 2 angles less than a right angle

Katerina

I can see 2 angles greater than a right angle

Lewis

I know _____ is right because_____

I know _____ isn't right because_____

right angle, less than, greater than,

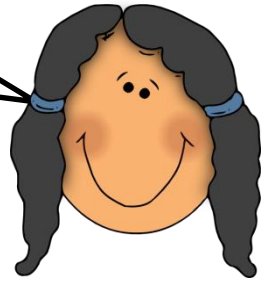
Concept mat – Year 4

LO: To count in multiples of 25

The next number will be 75

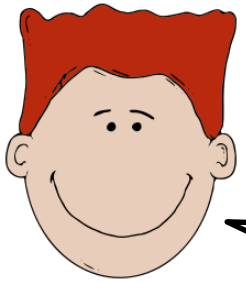
Ava

The next number will be 125



Estela

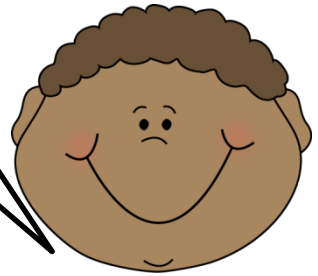
25,50,75,100 …



The next number will be 25 more than 100

Ben

The next number will be 225



Fazil

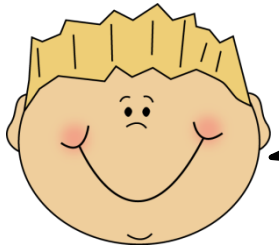
I know _____ is right because_____

I know _____ isn't right because_____

multiples, sequence, pattern, digit, continue, predict

Concept mat – Year 5

LO: To read Roman numerals to 1000

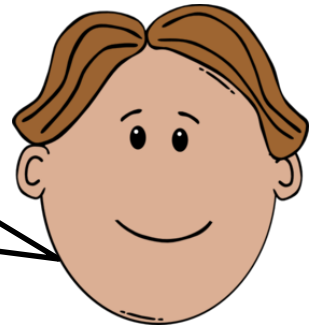


The number is 145

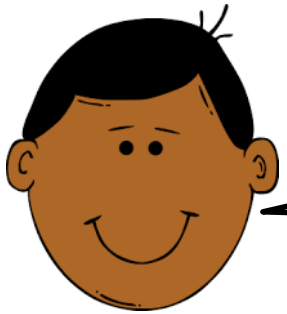
Thomas

CLV

The number is larger than 100



Jakub



The number is 551

Farouk

The number is 155

Katie

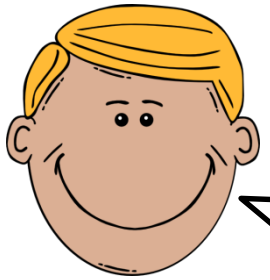
I know _____ is right because_____

I know _____ isn't right because_____

stands for, represents, equal to

Concept mat – Year 6

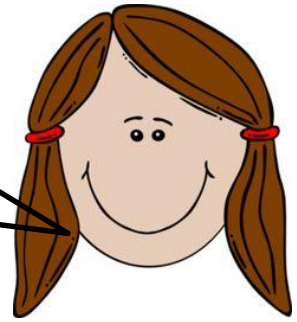
LO: To name parts of a circle



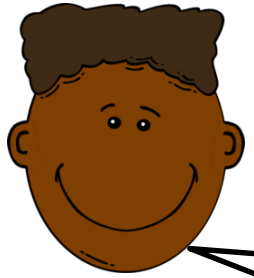
Noah

The red line represents the diameter of a circle

The red line is the radius of a circle



Amy



Talib

The red line is the circumference of a circle

The red line is twice the radius of a circle

Delmar

I know _____ is right because_____

I know _____ isn't right because_____

circle, radius, diameter, circumference, twice, half

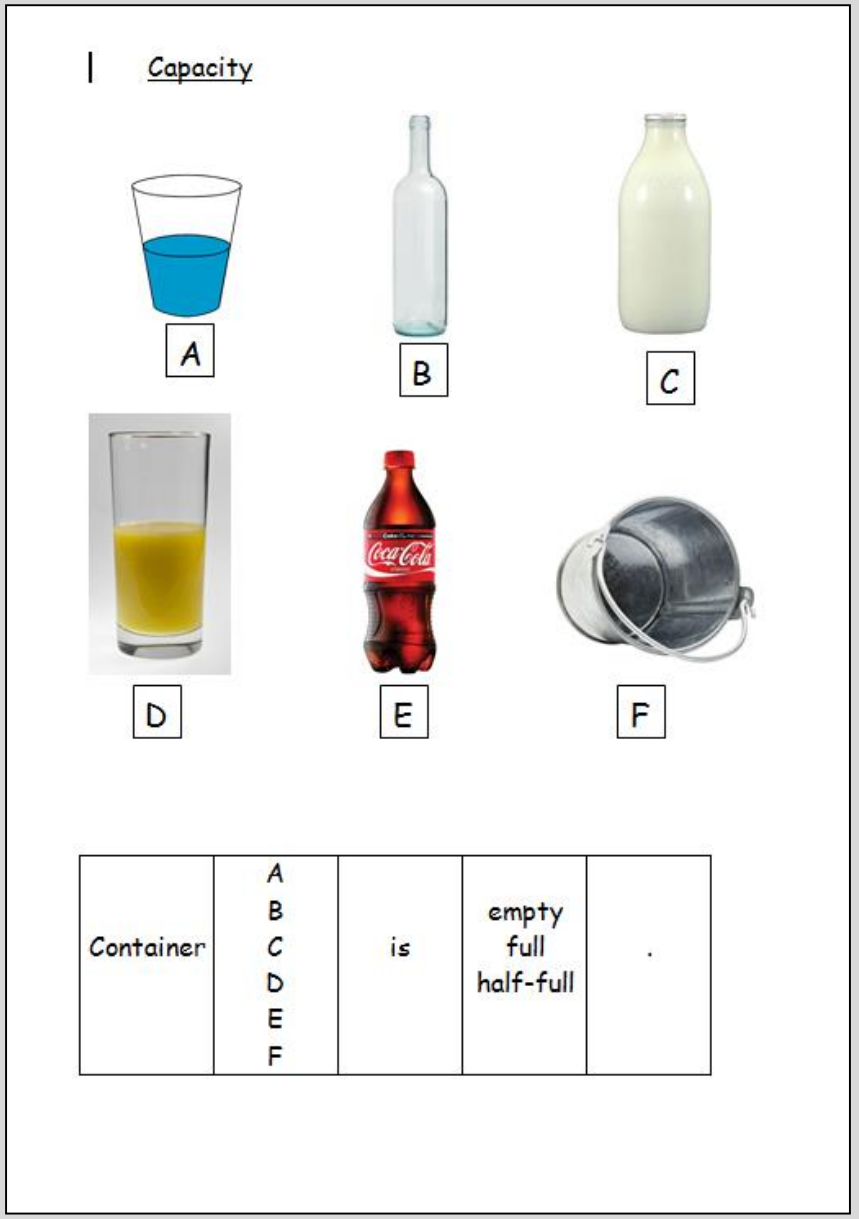
Substitution tables

- Provide scaffolded support for recording language-based answers to mathematical problems

Substitution table

Substitution tables are best used with pupils who have begun to engage a little with English, and who want to produce writing in their books like their peers. The alternative would be copying and not understanding what is being copied.

The pupils can make some word choices and begin to see how sentences are structured. They should be able to read the sentence back, or select the correct image if they are being silent.



Capacity

A

B

C

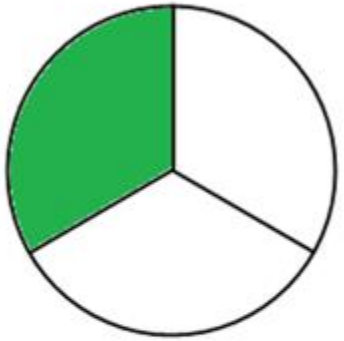
D

E

F

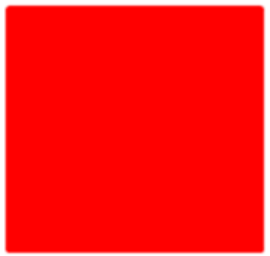
Container	A B C D E F	is	empty full half-full	.

Substitution table - Fractions



A	quarter half third	is	the	whole	divided	into	2 3 4	equal	parts	.

Substitution table – Shape



square

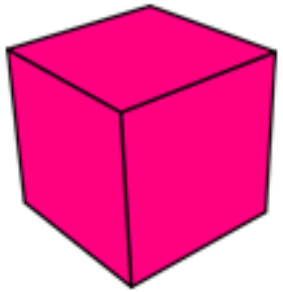
circle

rectangle

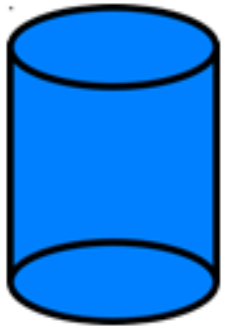
triangle

A	circle triangle square rectangle	has	1 3 4	side sides	and	0 3 4	corners	.

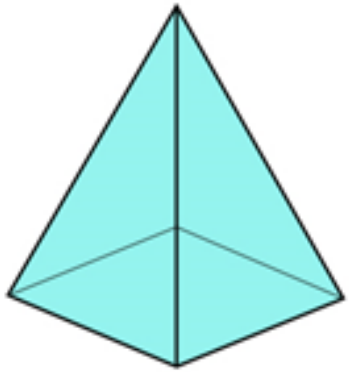
Substitution table - 3D shapes



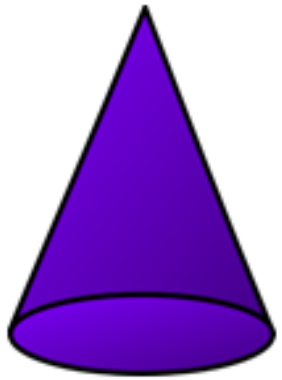
cube



cylinder



pyramid



cone

A	cone cube pyramid cylinder	has	2 3 5 6	faces	and	0 1 5 8	vertices	.

Group discussion

Take notes to help your thinking

Think:

Read the problem carefully and highlight key words.

Pair:

Talk to one person about your ideas

Square:

Join up with another pair & discuss your ideas

Share:

Share an idea from your group

Consider strategies for turn taking

Challenges:

1. A number rounded to the nearest tenth is 5.4. What number could I have rounded? Find the smallest and largest possible numbers.

2. A decimal number between 11 and 20 rounds to the same number when rounded to the nearest tenth and the nearest whole number. What could this number be? Is there more than one option? Explain why.

Universality of mathematical symbols and notation

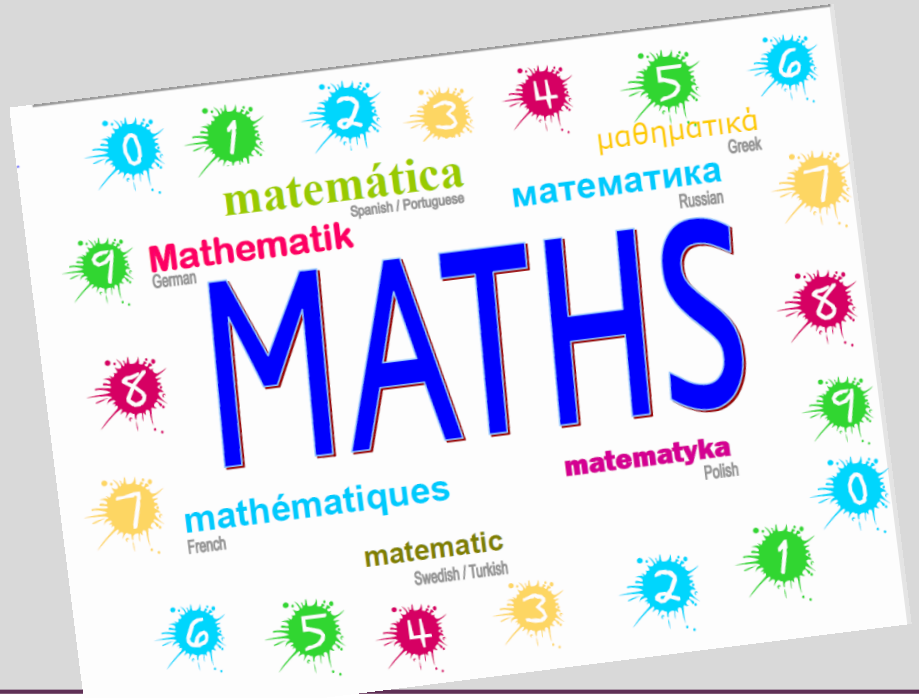
$4 \cdot 5$

$4 \cdot 5 = 20$

$12 : 6 = 2 : 1$

$12 : 6 = 2$

Exploring dual language resources



MATH GLOSSARY
Grades 3-5

ENGLISH	ROMANIAN
common factor	factor comun
common multiple	multiplu comun
commutative property of addition	proprietate de comutativitate a adunării
commutative property of multiplication	proprietate de comutativitate a înmulțirii
compare	compara
compare numbers	compara numere
compatible numbers	numere compatibile
compensation	compensație
complementary angles	unghiuri complementare
compose a number	compune un număr
compose shapes	compune figuri
composite number	număr compus
concentric circles	cercuri concentrice
conclusion	concluzie
concrete representations	reprezentări concrete
cone	con
congruent	congruent
congruent triangles	triunghiuri congruente
conjecture	Ipoteză
connect	conecta
consecutive	consecutiv
consecutive angles	unghiuri consecutive
constant	constantă
construct	construi
contrast	contrast
conversion fact	factor de conversie
convert	converti
coordinate	coordonată
coordinate grid	rețea de coordonate
coordinate plane	plan de coordonate
corner	colț
corresponding angles	unghiuri corespondente
corresponding sides	laturi corespondente
count back	număra invers
count backwards	număra descrescător
count on	număra
counterexample	contra-exemplu
counting numbers	numere naturale
cube	cub
cubic centimeter (cm^3)	centimetru cub (cm^3)
cubic unit	unitate cubică
cup (c)	reuniune (U)

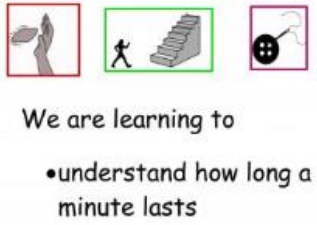
EAL resources

- https://ealresources.bell-foundation.org.uk/teachers/eal-nexus-resources

Maths scanning game

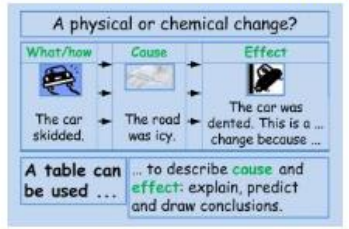
This colourfully designed resource can be used to develop scanning techniques and also to revise and consolidate basic maths vocabulary. This resource consists of a sheet full of wor relating to seven maths topics, with an accompanying informat sheet with topic headings and word lists.

How long is a minute?



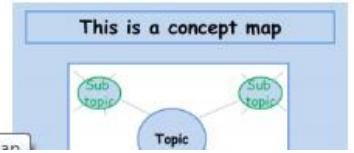
Learners find out how many times they can write their name, ca a beanbag, walk to the stairs and back and do other fun tasks ir one minute and record their results in different ways. There are activities which promote speaking and listening between partne and/or small groups and is suitable for use with the whole clas

Graphic organiser: classifying - table



The versatility of visual organisers makes them an excellent too support learners with English as an additional language.

Graphic organiser: classifying - concept map

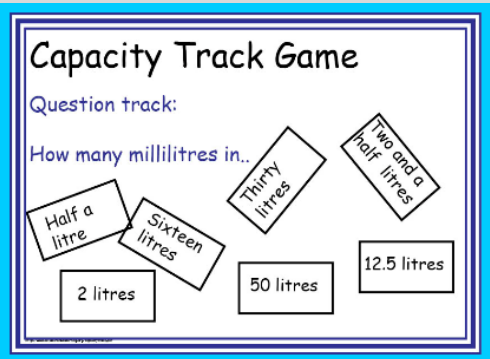


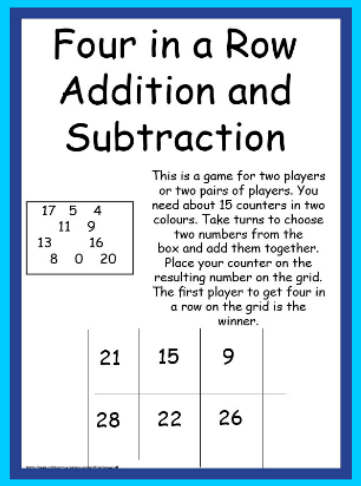
The versatility of visual organisers makes them an excellent too support learners with English as an additional language.

EAL resources

- www.collaborativelearning.org

This new revised webpage tries to make each activity clear in one poster. We have revised and updated many of the activities. We will post our most recent activity in the box on the right…





Dictionary websites

- http://www.amathsdictionaryforkids.com/dictionary.html

- http://go.hrw.com/math/midma/gradecontent/manipulatives/Glossary/Glossary.html?sz_term=undefined

Reasoning and Convincing at KS1

It's quite hard to pin down what 'reasoning' looks like. At KS1 we're looking for good 'because' statements. And if there are two or more which make a chain, that's progress.

I Like ...

Stage: 1 ★

Mr Gilderdale is playing a game with his class. What rule might he have chosen? How would you test your idea?

In the Playground

Stage: 1 and 2 ★★

What can you say about the child who will be first on the playground tomorrow morning at breaktime in your school?

A Bag of Marbles

Stage: 1 ★★

Use the information to describe these marbles. What colours must be on marbles that sparkle when rolling but are dark inside?

How Odd

Stage: 1 ★★

This problem challenges you to find out how many odd numbers there are between pairs of numbers. Can you find a pair of numbers that has four odds between them?

Two Numbers Under the Microscope

Stage: 1 ★★

This investigates one particular property of number by looking closely at an example of adding two odd numbers together.

Lots of Lollies

Stage: 1 ★★★

Frances and Rishi were given a bag of lollies. They shared them out evenly and had one left over. How many lollies could there have been in the bag?

Reasoning and Convincing at KS2

John Mason talks about convincing yourself, convincing a friend and convincing a sceptic. If your pupils don't know what a sceptic is, now's a good time to help them to understand!

Beads and Bags

Stage: 1 and 2 ★

How could you put these three beads into bags? How many different ways can you do it? How could you record what you've done?

Fifteen Cards

Stage: 2 ★

Can you use the information to find out which cards I have used?

Spot Thirteen

Stage: 2 ★

Choose 13 spots on the grid. Can you work out the scoring system? What is the maximum possible score?

Money Bags

Stage: 2 ★★

Ram divided 15 pennies among four small bags. He could then pay any sum of money from 1p to 15p without opening any bag. How many pennies did Ram put in each bag?

Sealed Solution

Stage: 2 ★★

Ten cards are put into five envelopes so that there are two cards in each envelope. The sum of the numbers inside it is written on each envelope. What numbers could be inside the envelopes?

Magic Vs

Stage: 2 ★★

Can you put the numbers 1-5 in the V shape so that both 'arms' have the same total?

The Puzzling Sweet Shop

Stage: 2 ★★

There were chews for 2p, mini eggs for 3p, Chocko bars for 5p and lollypops for 7p in the sweet shop. What could each of the children buy with their money?

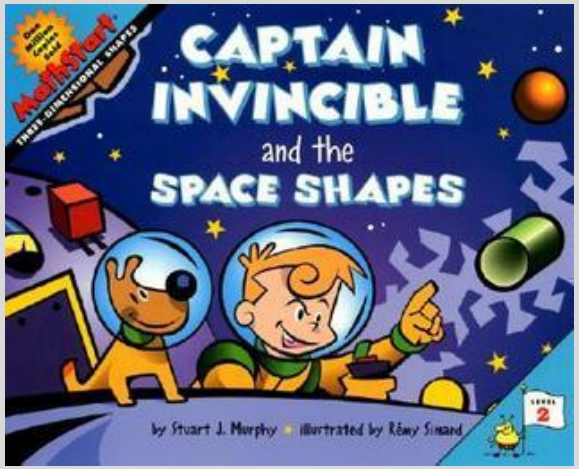
What's it Worth?

Stage: 3 and 4 ★

There are lots of different methods to find out what the shapes are worth - how many can you find?

Books

- The Greedy Triangle (Scholastic Bookshelf) by Marilyn Burns ISBN-13: 978-0545042208
- Captain Invincible and the Space Shapes (MathStart 2) ISBN-13: 978-0064467315
- A Triangle for Adaora: An African Book of Shapes by Ifeoma Onyefulu ISBN-13: 978-1845077389
- Mummy Math: An Adventure in Geometry Paperback by Cindy Neuschwander ISBN-13: 978-0312561178



Songs

- Sesame Street - "Shapes in My Room“ https://www.youtube.com/watch?v=GiMwcxaFsIY&t=15s
- The Shapes Song https://www.youtube.com/watch?v=v38vp3IwLho
- Shape song https://www.youtube.com/watch?v=xJxq0kR8yNc
- 3D shapes I know https://www.youtube.com/watch?v=2cg-Uc556-Q
- 3D shape song https://www.youtube.com/watch?v=guNdJ5MtX1A
- What shape is it? https://www.youtube.com/watch?v=NaNrzQUyuPQ

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beautiful

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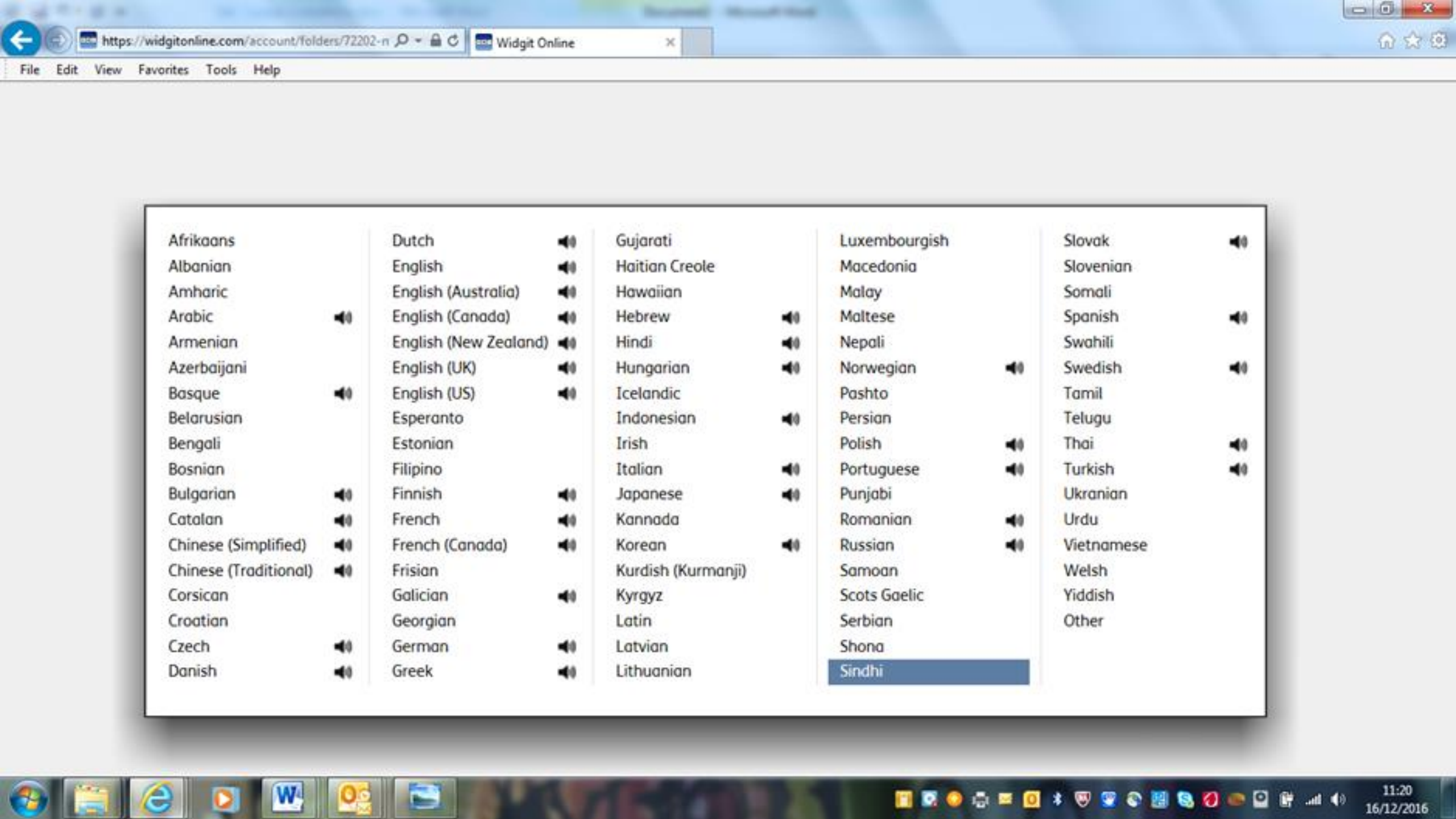
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Catalan
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Chinese (Traditional)
Corsican
Croatian
Czech
Danish
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English
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English (Canada)
English (New Zealand)
English (UK)
English (US)
Esperanto
Estonian
Filipino
Finnish
French
French (Canada)
Frisian
Galician
Georgian
German
Greek
Gujarati
Haitian Creole
Hawaiian
Hebrew
Hindi
Hungarian
Icelandic
Indonesian
Irish
Italian
Japanese
Kannada
Korean
Kurdish (Kurmanji)
Kyrgyz
Latin
Latvian
Lithuanian
Luxembourgish
Macedonia
Malay
Maltese
Nepali
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Pashto
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Shona
Sindhi
Slovak
Slovenian
Somali
Spanish
Swahili
Swedish
Tamil
Telugu
Thai
Turkish
Ukranian
Urdu
Vietnamese
Welsh
Yiddish
Other
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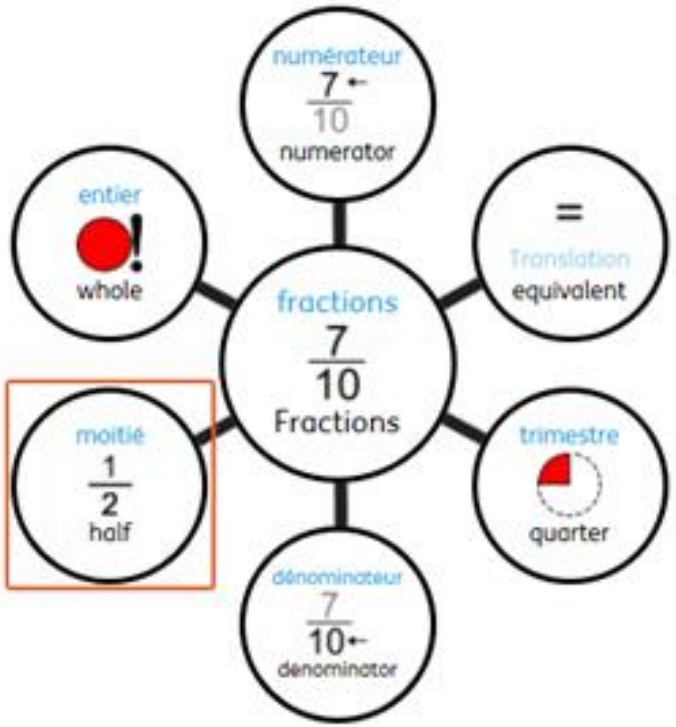
Fractions



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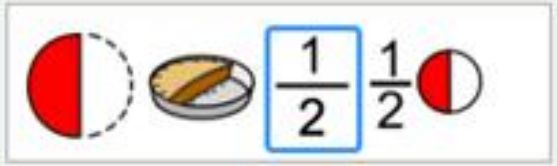

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‘what we can do in collaboration today, tomorrow we can do alone’

Conclusion

- The ability to verbalise thinking and to justify answers is a vital skill in ensuring children understand and retain mathematical concepts.
- This requires a focus not just on key vocabulary but also on sentence structures which must be regularly modelled and scaffolded for children.
- Listening to your pupils talk is also the best feedback you can get to assess what they are actually learning.
- It is essential therefore that maths lessons and activities have speaking and listening at their core.