



Developing **number**

Optional Skills Assessment Materials

Secret codes



Optional Skills Assessment Materials

Developing number

Audience	Teachers at Key Stage 2, in particular those with Year 5 classes; local authorities; tutors in initial teacher training; and others with an interest in education.
Overview	These new materials support learning, teaching and assessment of learners' skills in Year 5. They are designed to assist schools in implementing the revised school curriculum and its frameworks.
Action required	Schools' senior managers and local authority advisers are requested to raise awareness of these new materials within their schools, and to encourage teachers to use the materials to support their focus on developing learners' skills.
Further information	Enquiries about this document should be directed to: Curriculum and Assessment Division Department for Children, Education, Lifelong Learning and Skills Welsh Assembly Government Cathays Park Cardiff CF10 3NQ Tel: 0800 083 6003 e-mail: C&A3-14.C&A3-14@wales.gsi.gov.uk
Additional copies	Can be obtained from: Tel: 0845 603 1108 (English medium) 0870 242 3206 (Welsh medium) Fax: 01767 375920 e-mail: dcells1@prolog.uk.com Or by visiting the Welsh Assembly Government's website www.wales.gov.uk/educationandskills
Related documents	<i>Optional Skills Assessment Materials for Year 5 – An overview;</i> <i>Optional Skills Assessment Materials: Developing communication;</i> <i>Optional Skills Assessment Materials: Developing thinking</i> (Welsh Assembly Government, 2009) These materials are also available in Welsh.

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Overview

Three related activities based around a central theme of secret codes are provided:

- **Activity 1: Number codes**
- **Activity 2: Pattern codes**
- **Activity 3: Braille patterns**

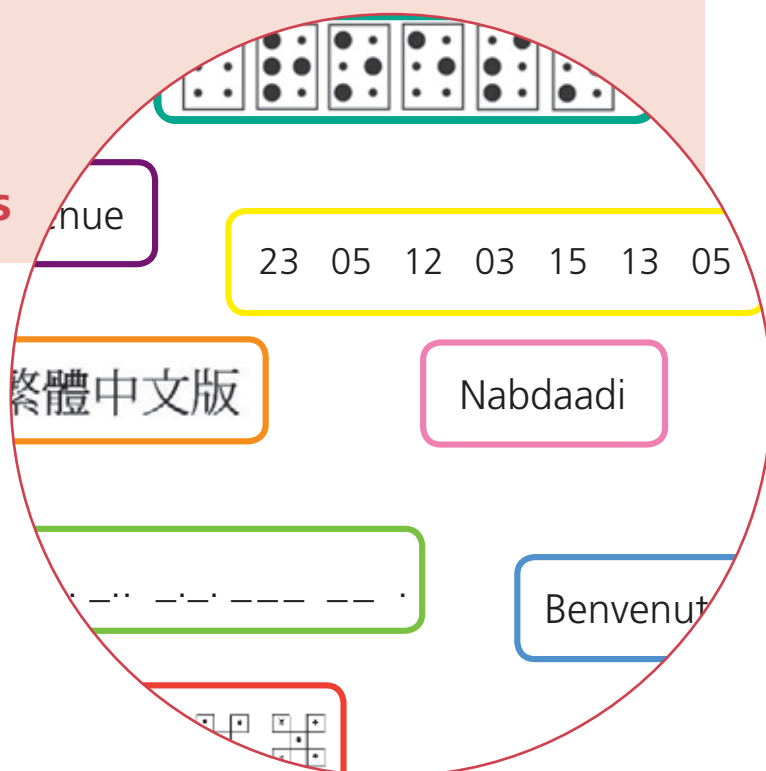
In Activity 1, learners consider a variety of ways in which a message can be written and sent. Learners then work collaboratively to interpret a message written in number code, before devising their own messages using other number codes.

In Activity 2, learners consider the implications of coding messages using patterns instead of numbers. They investigate the different patterns that can be made using combinations of dots and crosses on a given grid, before considering how these patterns can be used to devise a coding system. Finally, learners devise their own pattern code and consider the advantages and disadvantages pattern codes may afford when compared with number codes.

In Activity 3, learners consider the English Braille alphabet and the way in which letters are represented by combinations of raised dots on a grid of six dots. Learners then investigate the number of Braille-like patterns that can be made on a grid of four dots and a grid of three or five dots, with the aim of predicting the number of patterns that can be made on larger grids.

These activities are not timed assessment tasks, so you should feel free to adapt the materials provided to suit the needs of your learners.

The timings given at the beginning of each activity are suggestions. Some activities may take less time, while others may take considerably more. This will depend on the routes learners take and their interest in the activity itself.



Learner groupings

To promote collaborative learning, most activities are best undertaken by groups or pairs of learners who should be encouraged to share and discuss their ideas. At appropriate times, these groups could come together to present and compare their findings and the methods they use.

At other times, you may wish learners to work individually to provide evidence of their knowledge and skills. Consequently, the worksheets that accompany the activities can be used with groups, pairs or individuals as you consider appropriate.

Links to the skills framework

As learners engage with these materials they will generate evidence that contributes to their individual skills profile.

The 'Developing number across the curriculum' section of the skills framework has three main elements: **Use mathematical information**, **Calculate** and **Interpret and present findings**, with each of these sub-divided into a further two or three strands. These strands are referred to as 'principles' in the skills framework and are shown below.

Use mathematical information

- Using numbers
- Measuring
- Gathering information

Calculate

- Using the number system
- Using a variety of methods

Interpret and present findings

- Talking about and explaining work
- Comparing data
- Recording and interpreting data and presenting findings

Each principle contains six cells that correspond to stages in the development of the related skill. For example, the six cells identified in the **Using numbers** principle are shown below.

Use numbers in games and role play.	Use whole numbers in practical situations; use fractions in the context of simple shape. Recognise and use coins of different values.	Use decimals in the context of money and measures; use negative numbers in the context of temperature; use fractions and percentages to estimate, describe and compare proportions of a whole in practical contexts.	Use ratio and proportion in practical contexts, including currency exchange rates, value for money and scale drawings.	Use whole numbers, decimals, fractions, percentages, negative numbers, ratio and proportion in a variety of ways in practical contexts, including scale drawings, maps and plans.	Read and understand ways of writing very small and very large numbers.
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Evidence generated by the activities can be linked with cells to provide an indication of an individual learner's progress in the related skill area.

However, when doing this you should bear in mind the following points:

- The evidence generated by the activities will be a small part of the overall evidence that is available to you.
- Much evidence will be generated during other day-to-day learning and teaching; significant elements of this should also contribute to the learner's skills profile.
- The evidence generated by any activity is likely to contribute to a variety of principles and cells.

This final point is of particular importance when you review the **What to look for** section included with each of the activities.

These sections are designed to make evidence gathering more manageable by deliberately focusing on just two or three of the eight principles. However, this means that only some of the evidence that emerges is being considered.

As your familiarity with each of the activities increases, you may find that you are able to incorporate more of the available evidence into a variety of other principles and/or cells.

Links to the curriculum

PSE

Skills: Developing thinking

- form personal opinions and make informed decisions

PSE

Skills: Developing communication

- listen carefully, question and respond to others

PSE

Skills: Working with others

- work cooperatively to solve problems

English (Oracy)

Skills:

3. communicate clearly and confidently, expressing opinions, adapting talk to audience and purpose, using appropriate gesture, intonation and register in order to engage the listener

Science

Skills: Enquiry, Planning

2. (make) predictions using some previous knowledge and understanding

Mathematics

Skills: 1. Solve mathematical problems

- identify, obtain and process information needed to carry out the work

Mathematics

Skills: 2. Communicate mathematically

- recognise, and generalise in words, patterns that arise in numerical, spatial or practical situations

Mathematics

Skills: 3. Reason mathematically

- develop early ideas of algebra and mathematical structure by exploring number sequences and relationships; explain and predict subsequent terms
- investigate and generalise repeating patterns and relationships; search for pattern in their own results

Activity 1: Number codes



Links to the skills framework

In order to make evidence gathering more manageable, it is suggested that you concentrate initially on each of the principles shown as a main focus in the table below.

Use mathematical information

- Using numbers
- Measuring
- Gathering information

Calculate

- Using the number system
- Using a variety of methods

Interpret and present findings

- Talking about and explaining work
- Comparing data
- Recording and interpreting data and presenting findings

Key

- Main focus ● Incidental focus
- No intentional focus

The **What to look for** section at the end of this activity provides an indication of some of the evidence that you might expect and the cells with which this evidence might be matched. However, it is important to appreciate that a range of other evidence may also be generated and that this may be more validly associated with other principles and/or cells.

Context

This activity is in three parts. Consequently, you may wish to spread it over three or more sessions.

In the first part of the activity, learners consider similarities and differences in the presentation of a message written in a variety of different languages and codes. They also discuss why messages might be written in code and the various ways in which messages can be sent.

In the second part of the activity, learners are challenged to interpret a second message by 'cracking' the number code used.

Finally, learners consider a variety of other ways of creating number codes, using these to interpret and encrypt their own messages.

The activity not only provides opportunities for learners to demonstrate their thinking and number skills, but also provides ample opportunities for them to use their communication and team-working skills as they develop and share their ideas.

Resources

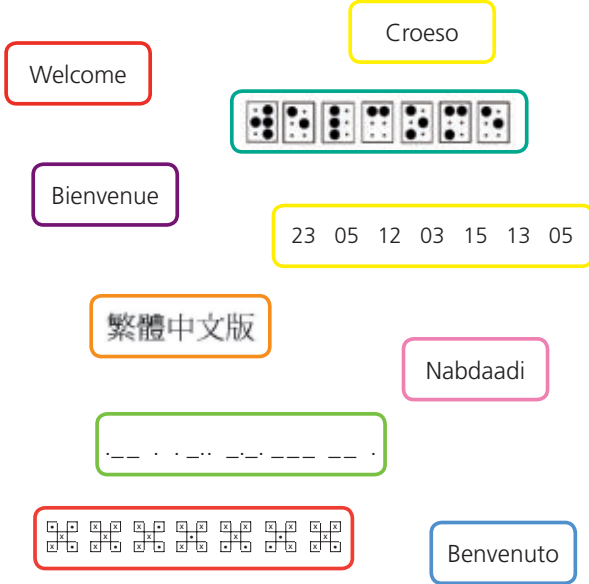
Two discussion sheets and one activity sheet are provided.

Each group of learners will need to be provided with a copy of the relevant sheet as the activity progresses.

Activity 1 | Number codes

Developing the activity (part 1)

- Display a copy of Discussion sheet 1 on the whiteboard and/or distribute a copy to each group of learners.
- Stimulate whole-class discussion and thinking by asking questions such as:
 - What do you think the discussion sheet shows?
 - Why do you think the messages are written in different ways?
 - Are any of the messages similar?
 - Are any of them different?
 - Why do you think messages might be written in code?
- As learners provide feedback, encourage other learners to comment and/or ask further questions.
- After the general introduction, ask learners to work in groups, suggesting ways in which messages can be sent.
- Some learners may identify ways in which messages can be sent by reference to the means of communication, e.g. 'by text', 'by telephone', or 'by e-mail'. Others may have more subtle suggestions, e.g. 'You can welcome someone with open arms or by putting out the welcome mat', 'By using body-language', 'By ringing a fire alarm', 'By firing a gun to start a race', etc.
- Careful observation of learners as they work will provide opportunities for gathering evidence relating to thinking, communication and number skills.
- Allow adequate time for groups to discuss the patterns before bringing them together to share and compare their ideas.
- Selecting particular learners to report back will provide further opportunities for you to gather specific evidence about individuals.

Secret codes	Activity 1: Number codes	Discussion sheet 1
Look at these messages.		
		
How are these messages similar? How are these messages different? Why might some messages be written in code? How can messages be sent?		

An example of classroom practice

Discussion sheet 1 was displayed on the whiteboard as part of a whole-class introduction. Learners soon recognised that all the messages probably said 'Welcome' and tried to outdo each other by suggesting the different languages and codes that had been used.

Braille and Morse code were identified and it was suggested that the line of numbers was also a code in which letters had been numbered from 1 to 26.

The unfamiliar pattern in the bottom left-hand corner puzzled learners until it was spotted that the second and last symbols were the same, suggesting that it was probably another coded way of writing 'Welcome'.

Learners were then asked to work in groups to suggest ways in which a message can be sent.

- letters
- E-mail
- Text messages
- Calling on a phone
- Signing language
- Flashing lights.
- Smoke
- Flag Flags
- Noises
- Retractors

- People who are locked in a cell can tap morse code on pipes and walls
- deaf people use sign language
- light houses tell sailors about rock dangers
- flares can tell people about danger from close and long ranges

Before moving on, the teacher brought the groups back together so that they could share their ideas. These were summarised by the teacher on the whiteboard.

- Ways to Send Messages
- sign language & gestures ^{sometimes}
 - talking, shouting, ^{ride}
 - phone / mobile phone
 - photos
 - complete - e-mail
 - text / MSN ^{code on painting}
 - letters through post
 - Flashing lights on fire engines, police cars etc
 - Morse Code + Bells
 - Drums
 - Songs, music - vibrations
 - smoke signals, Beacons
 - ultra-violet messages
 - video phones
 - birthday cards, Christmas cards etc
 - balloon messages
 - flowers with messages on
 - TV + radio - ^{emergency} messages
 - message in a bottle
 - hearts at Valentine's day
 - burglar alarms, fire alarms, shop alarms
 - Spanish Gires
 - Armada

Activity 1 | Number codes

Developing the activity (part 2)

- Distribute a copy of Discussion sheet 2 to each group of learners and ask them to identify the person who has cracked the code.
- As well as identifying reasons for selecting the correct answer of 'Cerys', learners should be encouraged to explain why the alternatives are 'incorrect'.

It's not 'suppers' because there's no double in the middle.

It's not 'hogwash' because the second and fifth letters need to be the same.

It can't be 'holiday' because the first and last letters have to be the same.

- Careful observation of learners as they work will provide opportunities for gathering evidence relating to thinking, communication and number skills.
- Allow adequate time for groups to discuss the patterns before bringing them together to share and compare their ideas.
- Selecting particular learners to report back will provide further opportunities for you to gather specific evidence about individuals.

Secret codes	Activity 1: Number codes	Discussion sheet 2
 The word is holiday Aled	 The word is hogwash Emily	
Moaz has written a word in code. 08 22 24 09 22 07 08 Who has cracked the code? Explain your reasoning.		
 The word is secrets Cerys	 The word is suppers Dafydd	

Developing the activity (part 3)

- Distribute a copy of the activity sheet to each group of learners and challenge them to interpret the messages shown.
- Careful observation of learners as they work will provide opportunities for gathering evidence relating to thinking, communication and number skills.
- Learners who have difficulty using Ayeshia's code should be encouraged to number all the letters of the alphabet from 1 to 26.

Handwritten number code for Ayeshia's message:

a	b	c	d	e	f	g	h	i	j	k	l
1	2	3	4	5	6	7	8	9	10	11	12
m	n	o	p	q	r	s	t	u	v	w	x
13	14	15	16	17	18	19	20	21	22	23	24
y	z										
25	26										

this is a very simple code

- However, when interpreting Ayeshia's message, learners need to appreciate that two digits are needed for each letter. Otherwise combinations such as 1221 could stand for abba, lba, abu, lu or ava.

a	b	c	d	e	f	g	h	i	j	k	l	m
01	02	03	04	05	06	07	08	09	10	11	12	13
n	o	p	q	r	s	t	u	v	w	x	y	z
14	15	16	17	18	19	20	21	22	23	24	25	26

- Learners may need similar support to help them read Paul's message.

Handwritten number code for Paul's message:

a	b	c	d	e	f	g	h	i	j
1	4	7	10	13	16	19	22	25	28
k	l	m	n	o	p	q	r	s	t
31	34	37	40	43	46	49	52	55	58
u	v	w	x	y	z				
61	64	67	70	73	76				

now things are getting interesting

Secret codes

a = 01 b = 02
c = 03...
x = 24 y = 25
z = 26

Activity 1: Number codes

Activity sheet

Ayeshia

I can use these numbers to write secret messages

Can you read Ayeshia's message?

20080919 0919 01 22051825 190913161205 03150405

Paul

To make the code harder, I can multiply each number by 3 and subtract 2

a = 01 b = 04
c = 07...
x = 70 y = 73
z = 76

Can you read Paul's message?

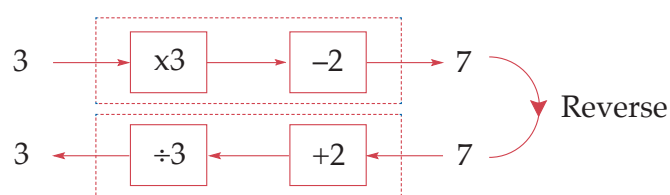
**404367 582225401955 015213 19135858254019
2540581352135558254019**

Make up your own number code and write some secret messages.

- Once learners have interpreted the two messages, encourage them to devise their own number code and use it to write a 'secret' message. Learners could do this individually or in pairs as you consider appropriate.

Activity 1 | Number codes

- The introduction of a 'key' on the activity sheet, that is 'multiply by 3 and then subtract 2', should encourage learners to use similar calculations themselves.
- Reversing a key 'unlocks' the code and returns an encrypted number to its original value. For example, in the case of 'multiply by 3 and then subtract 2', the reversal is 'add 2 and then divide by 3', so that $03 \rightarrow 07$ and when reversed $07 \rightarrow 03$.



- During the activity, you should introduce learners to this notion, asking them to suggest their own keys, and explaining how these could be 'unlocked', e.g. 'My key is multiply by 4 and add 3. To unlock the key, subtract 3 and divide by 4', etc.
- It is important that learners are allowed adequate time to develop this notion by investigating a number of keys and identifying the appropriate inverse operations.
- If appropriate, challenge learners to develop their ideas further by finding other ways of encoding messages.
- The messages and codes that learners produce should be exchanged with other learners for interpretation.
- To conclude the session, bring the groups back together to share and compare their ideas.
- Relevant suggestions can be followed-up and exploited over a number of additional sessions as appropriate.

To make my code I will multiply by ~~3~~ 3X

A	B	C	D	E	F	G	H	I	J	K
03	06	09	12	15	18	21	24	27	30	33
L	M	N	O	P	Q	R	S	T	U	V
36	39	42	45	48	51	54	57	60	63	66
W	X	Y	Z							
69	72	75	78							

to make my code I will use the 10 X table.

A	B	C	D	E	F	G	H	I	J	K
00	06	02	03	04	06	06	07	08	09	10
L	M	N	O	P	Q	R	S	T	U	V
11	12	13	14	15	16	17	18	19	20	
W	X	Y	Z							
21	22	23	24	25						

An example of classroom practice

Having interpreted the messages on the activity sheet, the learners were very enthusiastic about devising their own secret codes.

The teacher suggested that learners should work in pairs, devising codes and writing messages that could later be exchanged and interpreted.

Sophie and Katie worked with the key 'multiply by 4 and add 2', taking turns to calculate and then check each other's work, for example, $1 \times 4 + 2 = 6$, $2 \times 4 + 2 = 10$, etc.

After a while, the girls noticed that each of the numbers they had calculated was 'going up by four'. Although they saw this as a quick method of generating further numbers, they were still careful to check each of their answers using the key.

On reaching the last two letters, they found that the coded values were 3-digit numbers ($25 \times 4 + 2 = 102$, $26 \times 4 + 2 = 106$). This prompted them to go back and amend all of their other values to three digits.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
06	10	14	18	22	26	30	34	38	42	46	50	54	58	62	66	70
R	S	T	U	V	W	X	Y	Z								
74	78	82	86	90	94	98	102	106								

As 3-digit numbers were also occurring in other learners' calculations, the teacher intervened to discuss the issue with the class. To avoid confusion, it was agreed that all codes would be written using three digits.

Having completed their code, Sophie and Katie used it to write a message that was then exchanged (along with the relevant key of 'multiplying by 4 and adding 2') with Alun and Jac.

To interpret the message, the boys divided it up into 3-digit blocks, before considering how these numbers could be turned back into letters.

018/062 102/062/086 050/038/046/022 054/006/082/034/078

Alun said the 18 could be made by multiplying 4 by 4 and then adding 2, so 18 was the fourth letter of the alphabet. Jac said that, '4 times 10 is 40, so 62 is a big letter'!

The teacher encouraged the boys to concentrate on how the key produced new numbers by multiplying and then adding 2.

Alun said, 'If we take away 2 from each number, we can multiply to find the letter. 62 take away 2 is 60, so we need to find what number makes 60 when you times it by 4'.

Activity 1 | Number codes

Jac agreed, re-iterating that 40 was 10 lots of 4, before using a calculator to find that, 'There are 15 lots of 4 in 60, so 62 is letter 15'. As the boys had ready access to a copy of the alphabet from their earlier work, they quickly identified this as 'o'.

The boys became quite excited about their method, quickly finding subsequent letters using a mixture of mental strategies ('Two 25s in 50, so four 25s in a 100'), previous results ('We've already done 62, that's o'), known facts ('22 take away 2 is 20 and 5 fours are 20') and further calculations.

During the reporting back period at the end of the lesson, the boys were able to talk about their methods with enthusiasm.

They said that, although they could have started again (writing out the alphabet, numbering letters 1 to 26 and using the given key as they had done when devising their own code), their new method was much more fun as it was 'like being real code breakers'.

During the reporting back session, the teacher also showed the class Sophie and Katie's pattern (6, 10, 14, 18, 22...) and asked if anyone could explain why a key of 'multiply by 4 and add 2' should give such a result.

Although no one could give a full explanation, it was agreed that it was something to do with multiplying by 4. Some learners identified similar patterns in their own work, for example, patterns increasing by three when multiplying by 3, while others were keen to see if the same thing happened for 'multiply by 4 and add 3', etc.

$\times 3 + 1$ a b c d e 4 7 10 13 17 +3 +3 +3 +3	$\times 3 + 4$ a b c d e 7 10 13 16 19 +3 +3 +3 +3
$\times 4 + 3$ a b c d e 7 11 15 19 23 +4 +4 +4 +4	$\times 4 + 5$ a b c d e 9 13 17 21 25 +4 +4 +4 +4

The teacher felt extremely pleased with the number work that had been undertaken and told the learners that they could investigate the patterns further in subsequent sessions.

What to look for

Using numbers

When discussing number codes, interpreting messages and/or encoding messages, do learners recognise that:

- numbers can be used as a way of representing letters (Cell 1)
- simple sequences of numbers, e.g. 1, 2, 3, ... or 26, 25, 24, ... can be used to encode messages (Cell 2)
- more sophisticated coding systems can be created by using a simple key, to transform the numbers 1, 2, 3, ..., e.g. 'multiply by 2 and add 3' or 'multiply by 3 and subtract 2' (Cell 3)
- other methods can be used to create number codes that are more difficult to crack, e.g. using different keys to transform odd and even numbers or using a key to transform the sequence 1, 3, 5, ... (Cell 4)?

Talking about and explaining work

When discussing number codes, working collaboratively or reporting back, are learners able to:

- talk about what they have done, referring to some of the numbers they have used (Cell 1)
- use the language of number and comparatives, and the symbols for the four operations (Cell 2)
- use correct mathematical language, symbols and notation when presenting work (Cell 4)?

Using a variety of methods

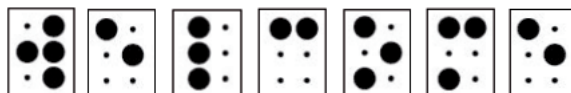
When discussing number codes, interpreting messages and/or encoding messages, are learners able to:

- match numbers with letters (Cell 1)
- use a variety of mental strategies to add and subtract small numbers (Cell 2)
- use a variety of methods of mental and written computation, e.g. when transforming numbers using keys (Cell 3)
- use inverse operations to 'unlock' a key (Cell 4)?

Look at these messages.

Welcome

Croeso



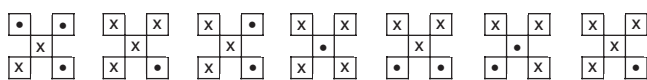
Bienvenue

23 05 12 03 15 13 05

繁體中文版

Nabdaadi

· _ _ · · _ · _ · _ _ _ _ ·



Benvenuto

How are these messages similar?

How are these messages different?

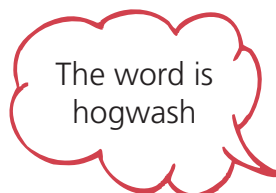
Why might some messages be written in code?

How can messages be sent?



The word is
holiday

Aled



The word is
hogwash

Emily



Moaz has written a word in code.

08 22 24 09 22 07 08

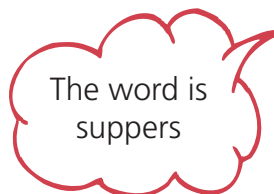
Who has cracked the code?

Explain your reasoning.



The word is
secrets

Cerys



The word is
suppers

Dafydd

a = 01 b = 02
c = 03...
x = 24 y = 25
z = 26

I can use these
numbers to write
secret messages

Ayeshia



Can you read Ayeshia's message?

20080919 0919 01 22051825 190913161205 03150405

To make the code
harder, I can multiply
each number by 3
and subtract 2

a = 01 b = 04
c = 07...
x = 70 y = 73
z = 76

Paul



Can you read Paul's message?

**404367 582225401955 015213 19135858254019
2540581352135558254019**

Make up your own number code and write some secret messages.

Activity 2: Pattern codes



Links to the skills framework

In order to make evidence gathering more manageable, it is suggested that you concentrate initially on each of the principles shown as a main focus in the table below.

Use mathematical information

- Using numbers
- Measuring
- Gathering information

Calculate

- Using the number system
- Using a variety of methods

Interpret and present findings

- Talking about and explaining work
- Comparing data
- Recording and interpreting data and presenting findings

Key

- Main focus ● Incidental focus
- No intentional focus

Context

This activity is in two parts. Consequently, you may wish to spread it over two or more sessions.

In the first part of the activity, learners are asked to identify any codes they may have met and to suggest situations in which codes are used. Learners then work in groups to investigate the different patterns that can be made on a given grid using combinations of dots and crosses, before considering how these patterns can be used to devise a coding system.

In the second part of the activity, learners devise their own pattern codes and consider the advantages and disadvantages of pattern codes when compared with number codes.

Resources

One activity sheet and one worksheet are provided.

In addition, a resource sheet showing the 32 patterns that can be made on the worksheet is provided.

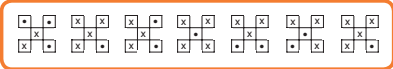
This resource sheet also indicates one of the many ways in which the letters of the alphabet can be linked with the 32 patterns.

The **What to look for** section at the end of this activity provides an indication of some of the evidence that you might expect and the cells with which this evidence might be matched. However, it is important to appreciate that a range of other evidence may also be generated and that this may be more validly associated with other principles and/or cells.

Activity 2 | Pattern codes

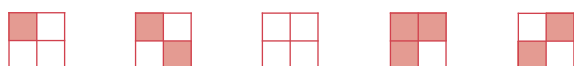
Developing the activity (part 1)

- Introduce the activity by reminding learners of the work they did using number codes.
- Stimulate whole-class discussion and thinking by asking learners to identify other codes they have met and situations in which codes are used. Suggestions may include bar codes, clothes tags, codes for safes, PINs, computer passwords, etc.
- Discuss whether or not their suggestions can be decoded.
- As learners provide feedback, encourage other learners to comment and/or provide further suggestions.
- After the general introduction, distribute a copy of the activity sheet to each group and ask them to investigate the various patterns that can be made with a dot or a cross in each square.
- An optional worksheet is provided to help learners structure their work.
- Careful observation of learners as they work will provide opportunities for gathering evidence relating to thinking, communication and number skills.
- Allow adequate time for learners to engage with the task before bringing them back together to present and compare their findings.
- Selecting particular learners to report back will provide further opportunities for you to gather specific evidence about individuals.

Secret codes	Activity 2: Pattern codes	Activity sheet
Nia uses patterns to make her secret code.  Instead of numbers, I can use patterns Nia  Here are some of the patterns that Nia makes:      How many patterns can Nia make using: - One dot and four crosses? - Two dots and three crosses? - Three dots and two crosses? - Four dots and one cross? How many patterns can Nia make altogether?		

Developing the activity (part 2)

- Distribute a copy of the resource sheet to each group.
- This shows the 30 different patterns that can be made using at least one dot and at least one cross.
- In addition, it shows the pattern that can be made using five dots and the pattern that can be made using five crosses.
- Stimulate whole-class discussion and thinking by asking questions such as:
 - What do you think the resource sheet shows?
 - Can you use it to read the message on the activity sheet?
 - Are there other ways in which the patterns could have been used to represent letters?
 - Can you suggest some other ways of doing this?
 - How could you use the patterns that do not represent letters?
- As learners provide feedback, encourage others to comment and/or ask further questions.
- Before moving on, you could ask learners to produce their own messages using Nia's code. These messages could then be exchanged with other learners for translation.
- After the general introduction, ask learners to work in groups, investigating other patterns that could be used to devise a code.
- To get learners started, you may need to suggest a basic framework for them to follow. For example, shading quadrants on a square grid will produce 16 different patterns, some of which are shown below.



Secret codes	Activity 2: Pattern codes	Resource sheet
Five patterns can be made using one dot and four crosses:		
a	b	c
d	e	
Ten patterns can be made using two dots and three crosses:		
f	g	h
i	j	
k	l	m
n	o	
Ten patterns can be made using three dots and two crosses:		
p	q	r
s	t	
u	v	w
x	y	
Five patterns can be made using four dots and one cross:		
z		
Two other patterns are possible:		

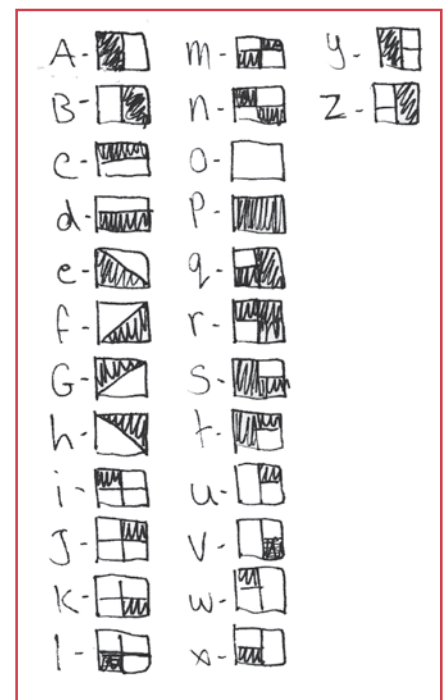
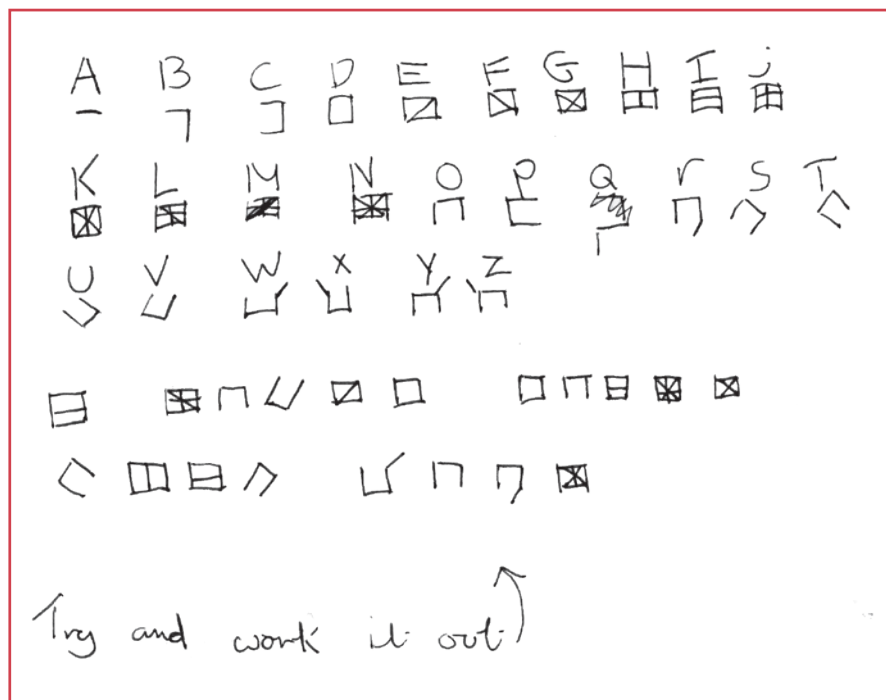


- Combining these with 10 of the 16 patterns that can be made by shading a 1 by 4 rectangular grid (three examples below) allows the whole alphabet to be covered.



Activity 2 | Pattern codes

- Encourage learners to be as creative as possible. As well as using other shapes, learners could use different colours or symbols to increase the number of options available.
- Careful observation of learners as they work will provide opportunities for gathering evidence relating to thinking, communication and number skills.
- Where appropriate, ask questions or make interventions designed to encourage learners to work systematically.
- Allow adequate time for groups to engage with this task, before bringing them together to share and compare their ideas.
- Selecting particular learners to report back will provide further opportunities for you to gather specific evidence about individuals.
- Finally, ask each group to consider the advantages and disadvantages of using patterns instead of numbers to write secret messages. (Pattern codes are more cumbersome and time consuming to produce, but the messages can be more difficult to interpret.)



What to look for

Gathering information

When investigating the number of different patterns that can be made using combinations of dots and crosses, are learners able to:

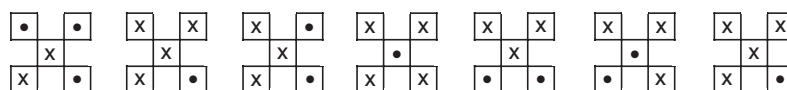
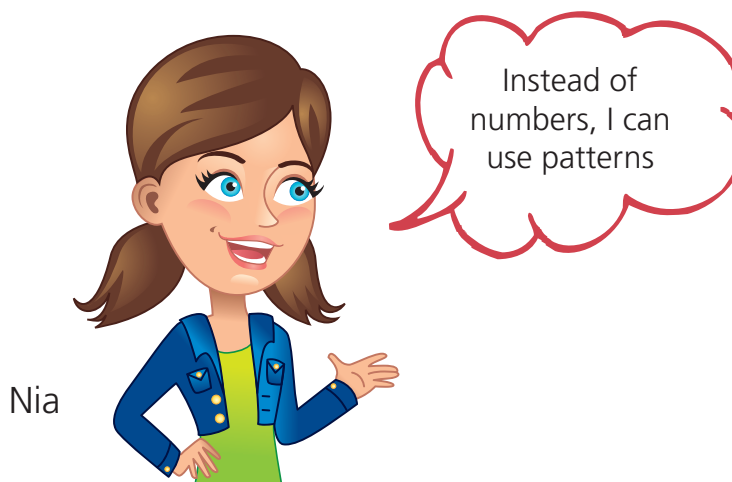
- identify and count a small number of the required patterns (Cell 1)
- work systematically to obtain most of the required patterns in each category (Cell 2)
- work systematically to obtain almost all of the required patterns in each category, explaining the methods used (Cell 3)?

Talking about and explaining work

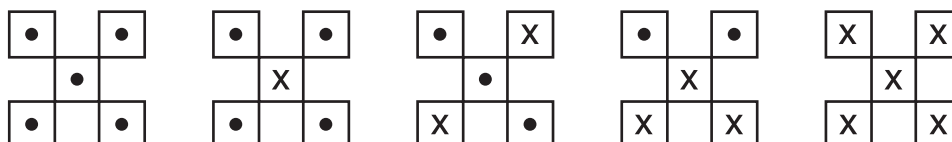
When discussing their work within the group and/or reporting back, are learners able to:

- make accurate references to the number of letters or patterns they have found (Cell 1)
- use the language of number, shape and comparatives, e.g. when comparing the number and shape of the patterns made on grids of different sizes (Cell 2)
- use the language of position and movement (Cell 3)
- explain the relationships they observe, e.g. 'There are five patterns using one dot because there are five different places to put the dot' or 'Using three dots and two crosses is the same as using three crosses and two dots, so there will be the same number of patterns' (Cell 4)?

Nia uses patterns to make her secret code.



Here are some of the patterns that Nia makes:



How many patterns can Nia make using:

- One dot and four crosses?
- Two dots and three crosses?
- Three dots and two crosses?
- Four dots and one cross?

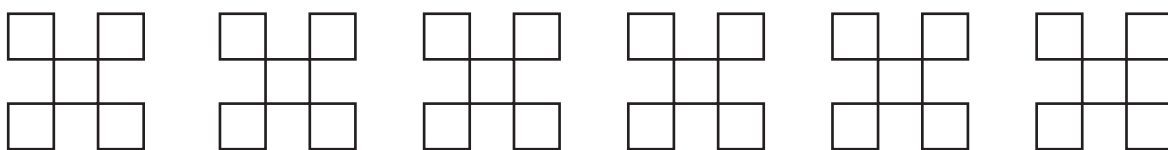
How many patterns can Nia make altogether?

Name(s):

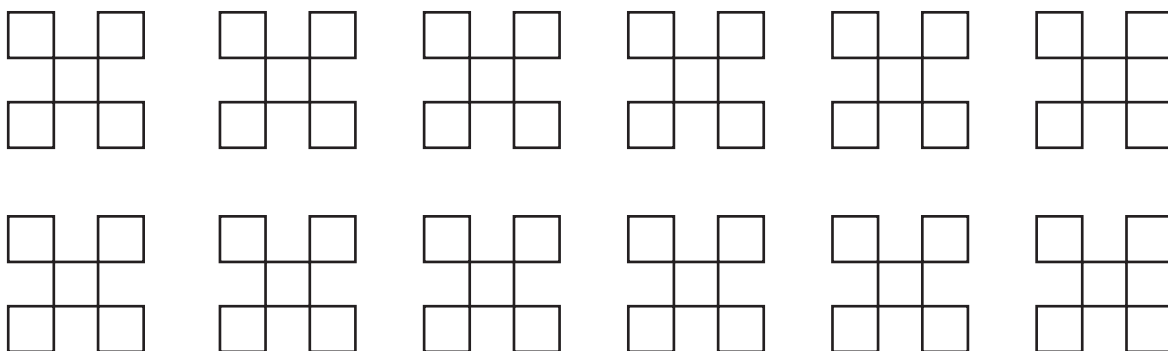
Make as many different patterns as you can.

You may not need to use all the grids.

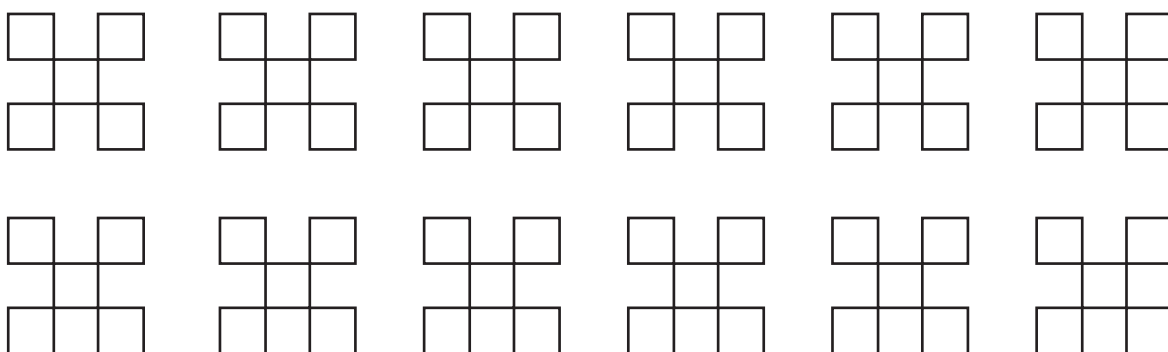
Patterns using one dot and four crosses



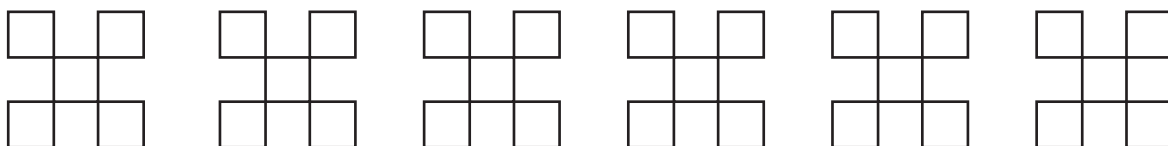
Patterns using two dots and three crosses



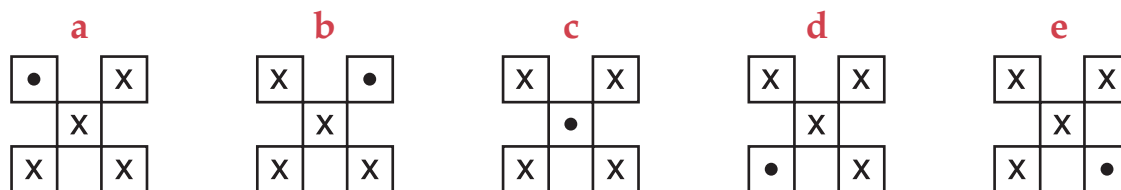
Patterns using three dots and two crosses



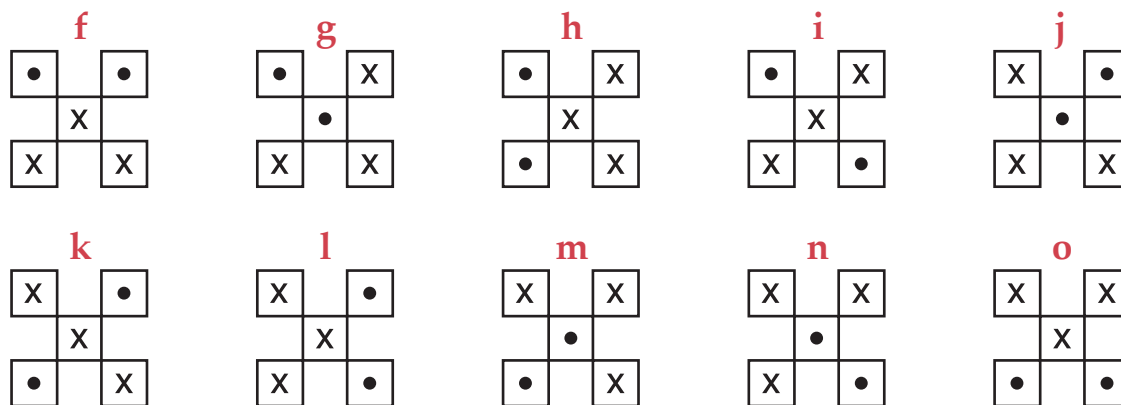
Patterns using four dots and one cross



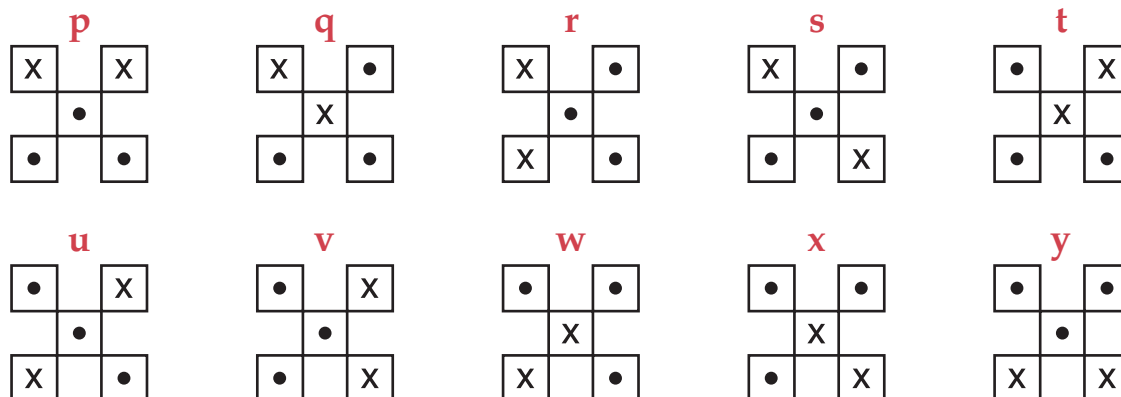
Five patterns can be made using one dot and four crosses:



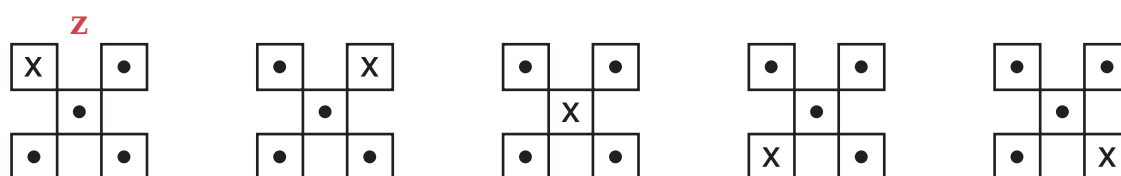
Ten patterns can be made using two dots and three crosses:



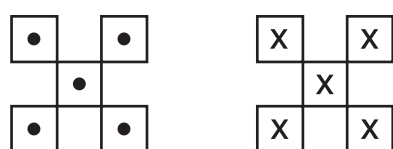
Ten patterns can be made using three dots and two crosses:



Five patterns can be made using four dots and one cross:



Two other patterns are possible:



Activity 3: Braille patterns



Links to the skills framework

In order to make evidence gathering more manageable, it is suggested that you concentrate initially on each of the principles shown as a main focus in the table below.

Use mathematical information

- Using numbers
- Measuring
- Gathering information

Calculate

- Using the number system
- Using a variety of methods

Interpret and present findings

- Talking about and explaining work
- Comparing data
- Recording and interpreting data and presenting findings

Key

- Main focus ● Incidental focus
- No intentional focus

The **What to look for** section at the end of this activity provides an indication of some of the evidence that you might expect and the cells with which this evidence might be matched. However, it is important to appreciate that a range of other evidence may also be generated and that this may be more validly associated with other principles and/or cells.

Context

This activity is in three parts. Consequently, you may wish to spread it over three or more sessions.

In the first part of the activity, learners are presented with a copy of the English Braille alphabet and asked to record the frequency of letters made using various numbers of raised dots.

In the second part of the activity, learners investigate the total number of Braille patterns that can be made using just one raised dot and two raised dots, before considering reasons why these additional patterns are not used in the Braille alphabet.

Finally, learners work collaboratively to investigate the total number of Braille-like patterns that can be made on a grid of three dots and a grid of four dots. If appropriate, this task can be extended to include two and five dot grids in order to investigate the relationship between the number of dots on a grid and the number of patterns that can be made.

Resources

One activity sheet and two worksheets are provided. Each group of learners will need to be provided with a copy of the relevant sheet as the activity progresses.

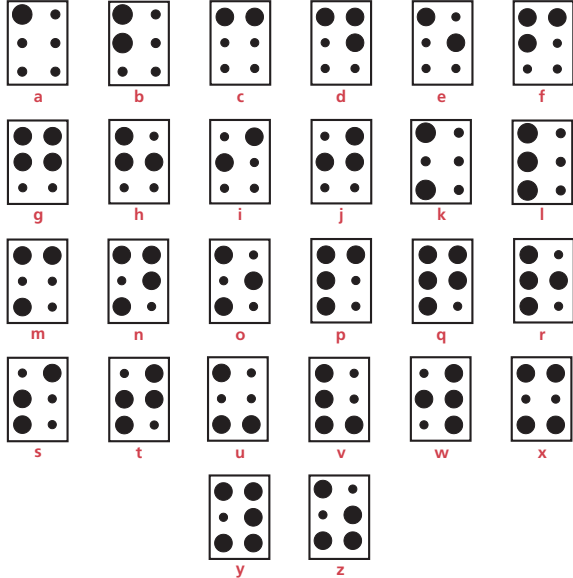
If possible, provide learners with examples of materials written in Braille.

To make the activity more practical, provide each group with a collection of counters that can be used to make patterns.

Activity 3 | Braille patterns

Developing the activity (part 1)

- The English Braille alphabet is based on a grid of six dots, with 26 different patterns of raised dots for the 26 letters of the English alphabet.
- Display a copy of the activity sheet on the whiteboard and/or distribute a copy to each group of learners.
- Stimulate whole-class discussion and thinking by asking questions such as:
 - Why is Braille important?
 - Do you know anyone who uses Braille?
 - Has anyone seen any Braille materials?
 - Why are some of the dots raised?
- If possible, provide learners with examples of materials written in Braille.
- After the general introduction, ask learners to work in groups to determine the frequency of letters made using various numbers of raised dots.
- Careful observation of learners as they work will provide opportunities for gathering evidence relating to thinking, communication and number skills.
- Allow adequate time for groups to discuss the patterns before bringing them together to share and compare their ideas.
- Selecting particular learners to report back will provide further opportunities for you to gather specific evidence about individuals.
- Following the reporting back session, you may wish to allow further time for learners to follow up the ideas discussed.

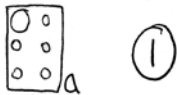
Secret codes	Activity 3: Braille patterns	Activity sheet
The English Braille alphabet is based on a grid of six dots. Some dots are raised so that they can be read by touch.		
		
How many letters are made using: • One raised dot? • Two raised dots? • Three raised dots? • Four raised dots? • Five raised dots? Show your results in an organised way.		

Some examples of learners' work

Number of dots	letters	total
1	a	1
2	b, c, e, i, k	
3	d, f, h, j, l, m, o, s, u	
4	g, n, p, r, t, v, w, x, z	
5	q, y	
6	0	0
total Score		26

number of dots	Total	letter
1	1	a
2	~~4~~ 5	yts + beikc ~~A~~ y
3	~~7~~ 9	jLmuhdfoS
4	9	qntvrzxwp
5	2	yq

One raised dot:



①

Two raised dots:
b, c, e, i, k ⑤

Three raised dots:
d, f, h, j, l, m, o, s, u ⑨

four raised dots:
g, n, p, r, t, v, w, x, z ⑨

five raised dots:
q, y ②

One raised dot
a

two raised dot
b c e i k

three raised dots
d f h j l m o
s u

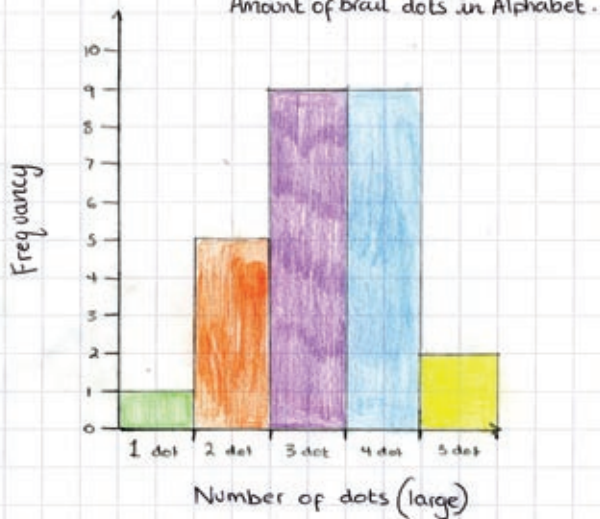
four raised dots
g n p r t v w x
z

five raised dots
q y

Activity 3 | Braille patterns

Number of dots	Frequency	
1	1	1
2	4 7	5
3	4 7 1 1 1 1	9
4	4 7 1 1 1 1	9
5	1 1	2

Amount of brail dots in Alphabet.



Braille alphabet

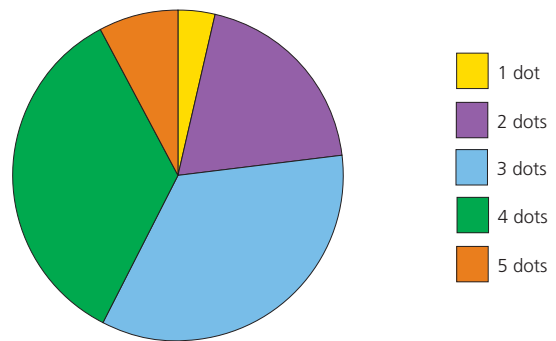
We looked at the Braille alphabet and looked how many raised dots were in the Braille pattern.

We found that there were:

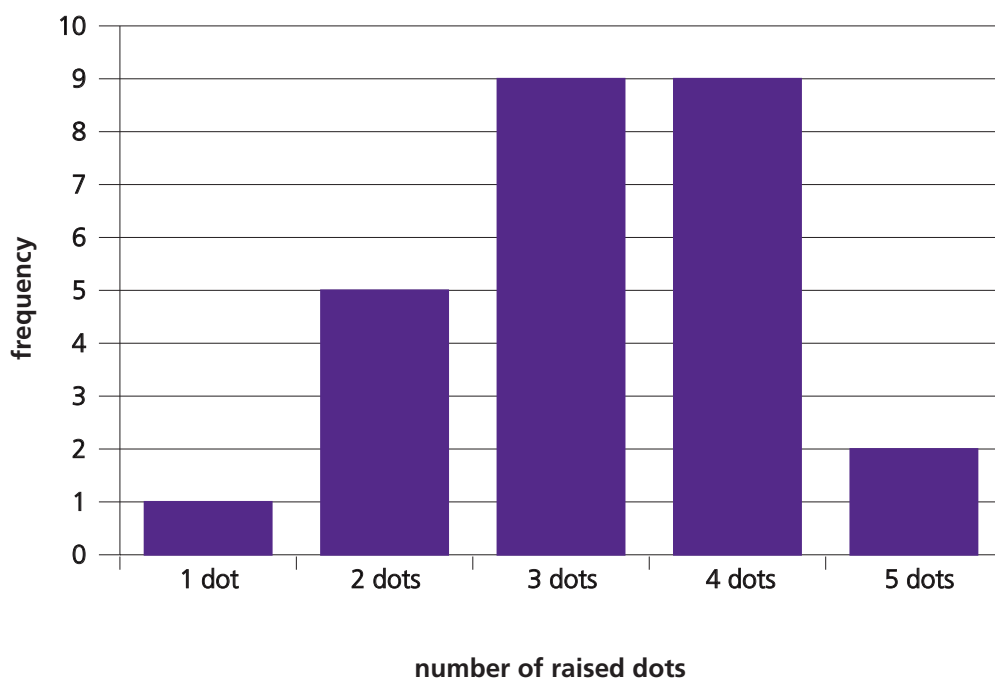
- 1 dot = 1 patterns
- 2 dot = 5 patterns
- 3 dot = 9 patterns
- 4 dot = 9 patterns
- 5 dot = 2 patterns

This makes a total of 26 patterns altogether and there are 26 letters in the alphabet.

pie chart showing how many raised dots



Patterns of raised dots

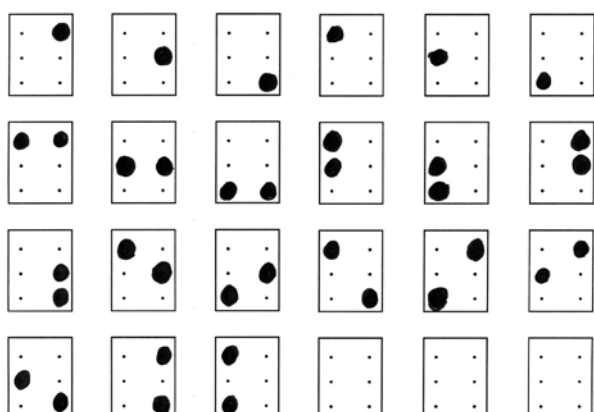


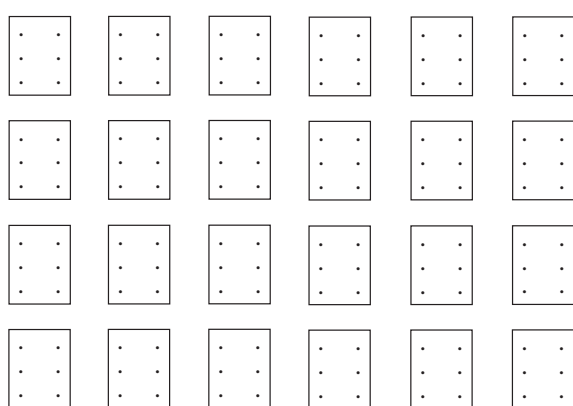
Developing the activity (part 2)

- Distribute a copy of Worksheet 1 to each group of learners.
- Explain that learners should work collaboratively to identify patterns that can be made using just one raised dot and patterns that can be made using just two raised dots.
- A good way to encourage collaboration is to tell learners that they should each take a turn suggesting a pattern.
- To be accepted, a pattern needs to be agreed by the group as being valid and different from any that have gone before.
- Careful observation of learners as they work will provide opportunities for gathering evidence relating to thinking, communication and number skills.
- When learners have had adequate time to engage with the task, bring them back together to discuss their findings.
- Why do they think that only some of the patterns they have made are used in Braille?

the reason why only one of these patterns are used once is because the blind person would not be able to tell which letter it was.

- Can they explain why only six patterns are possible using one raised dot and 15 using two raised dots?



Secret codes	Activity 3: Braille patterns	Worksheet 1
Name(s):		
The English Braille alphabet is based on a grid of six dots.		
		
Some dots are raised so that they can be read by touch.		
Investigate patterns that can be made using:		
(i) just one raised dot		
(ii) two raised dots.		
Why are only some of these patterns used in Braille?		
		



Activity 3 | Braille patterns

Developing the activity (part 3)

- Distribute a copy of Worksheet 2 to each group of learners.
- Explain that this task is different from the one on Worksheet 1 because this time more than two raised dots can be used.
- Once again, this could be a collaborative exercise in which individuals take a turn suggesting a new pattern that must be different from any that have gone before.
- To make the activity more practical in nature, learners could take turns arranging counters on an improvised board and then recording each new result obtained.

Seven patterns

Make as many different patterns as you can.

You may not need to use all the grids.

fifteen patterns

Secret codes	Activity 3: Braille patterns	Worksheet 2
--------------	------------------------------	-------------

Name(s):

Make as many different patterns as you can.

You may not need to use all the grids.

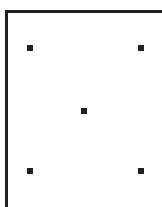
Make as many different patterns as you can.

You may not need to use all the grids.

3 patterns

dots	patterns
2	3
3	7
4	15
5	31

- Learners who have been successful in identifying most (or all) of the patterns on Worksheet 2, could be asked to make similar patterns on a grid of five dots or a grid of two dots.

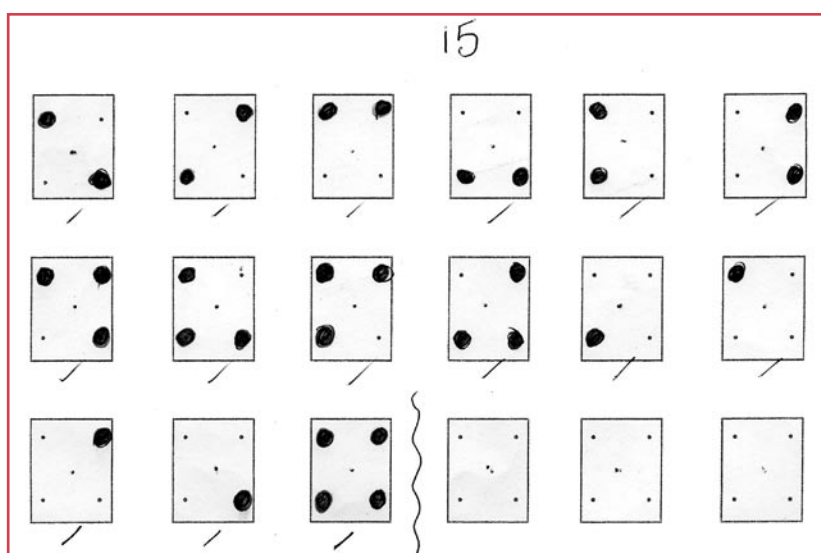


- When learners have had adequate time to engage with the task, bring them back together to discuss their findings and ideas.
- Learners who have been successful in extending the activity in either (or both) of these ways could be asked to summarise their results with a view to predicting the number of patterns that can be made on a grid of six or more dots.

An example of classroom practice

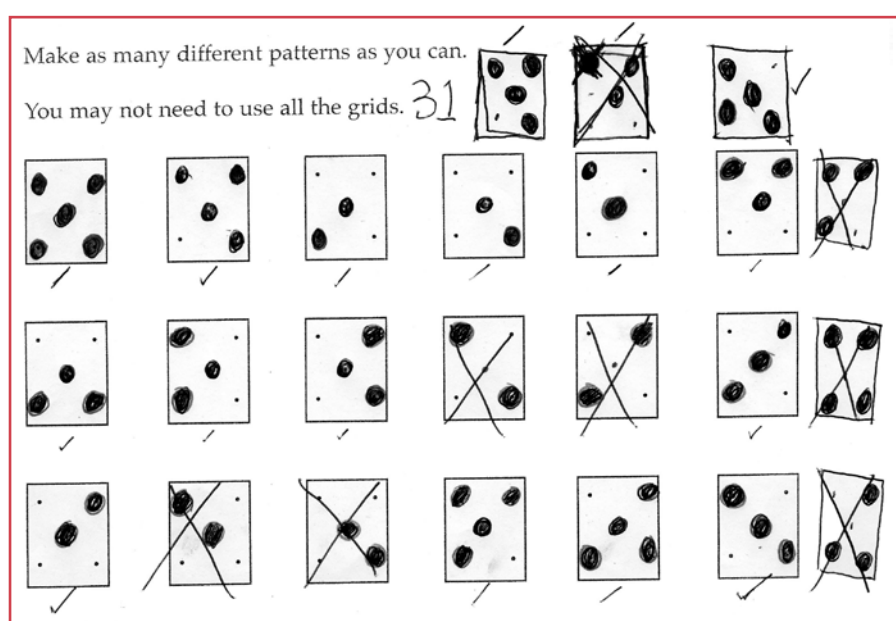
Having successfully identified the 15 patterns that can be made on a grid of four dots, the group attempted to find similar patterns on a grid of five dots.

Rhys said that the 15 patterns they had already recorded on Worksheet 2 could also be made on the new grid. The others looked puzzled, so Rhys took their previous recording and marked in a central dot on each of the grids.



The others were impressed and agreed that they now had 15 of the new patterns they needed. Sarah suggested they use another copy of Worksheet 2 to identify more patterns. This was agreed and the learners quickly adapted a copy of the worksheet by marking in a fifth dot on each grid.

The learners then took turns making new patterns on these grids. As they worked, each new pattern was checked by the group and agreed or crossed out.



When they had exhausted the 18 grids available on the worksheet, the learners continued to produce new patterns by drawing their own, additional grids.

Activity 3 | Braille patterns

As the group did not have a system for producing new patterns, the task became increasingly difficult as more and more patterns were recorded.

Eventually the group had identified 31 patterns and felt that they could not find any more. Interestingly, the correct number is 31, but the group have recorded one duplicate pattern (can you find it?) and omitted the pattern that can be made using just the one central dot.

A systematic way of identifying the 16 additional patterns is to add a central raised dot to each of the 15 patterns already made on the 4-dot grids. One further new pattern can then be made using just the central dot.

This method can be used as the basis of an argument to justify the way in which the number of different patterns increases. For example, if there are 15 patterns possible originally, then there will be $15 \times 2 + 1 = 31$ patterns possible when one new dot is added. Similarly, if there are 31 patterns possible originally, then there will be $31 \times 2 + 1 = 63$ patterns possible when one new dot is added.

The relationship between the size of the grid and the number of patterns that can be made is shown in the table below. Most learners are unlikely to be able to articulate the underlying rule, although some learners may be able to extend the pattern intuitively.

Size of grid	Number of different patterns
3 dots	7 (2 multiplied together 3 times, minus 1)
4 dots	15 (2 multiplied together 4 times, minus 1)
5 dots	31 (2 multiplied together 5 times, minus 1)
6 dots	63 (2 multiplied together 6 times, minus 1)

Some learners may also recognise that the number of patterns in each new row is obtained by doubling the number of patterns in the previous row and adding one, for example $15 = 2 \times 7 + 1$, $31 = 2 \times 15 + 1$, etc.

What to look for

Gathering information

When identifying the number of Braille-like patterns that can be made on various sized grids, are learners able to:

- identify and count a small number of the required patterns (Cell 1)
- obtain the information needed systematically, perhaps by first considering patterns made with one raised dot, then patterns made with two raised dots, etc. (Cell 2)
- gather the information required in a variety of ways, e.g. by using the patterns obtained on a grid of four dots to help find the patterns that can be made on a grid of five dots (Cell 3)?

Recording and interpreting data and presenting findings

When determining the frequency of letters made using various numbers of raised dots, are learners able to:

- record some of the letters that can be made (Cell 1)
- record accurately, perhaps in a simple table, list or chart, the results obtained (Cell 2)
- record accurate results in an appropriately labelled graph or diagram, interpreting and discussing the information shown as necessary (Cell 3)?

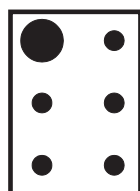
Talking about and explaining work

When discussing their work within the group and/or reporting back, are learners able to:

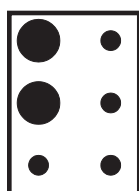
- make accurate references to the number of letters or patterns they have found (Cell 1)
- use the language of number, shape and comparatives, e.g. when comparing the number and shape of the patterns made on grids of different sizes (Cell 2)
- use correct mathematical language, symbols and notation when presenting work, e.g. when explaining why only 15 Braille patterns can be made using two raised dots (Cell 4)?

The English Braille alphabet is based on a grid of six dots.

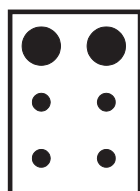
Some dots are raised so that they can be read by touch.



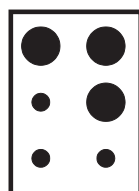
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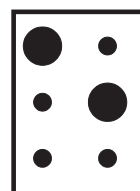
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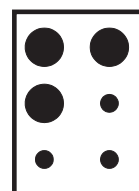
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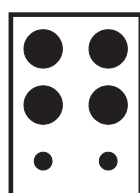
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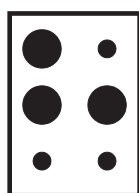
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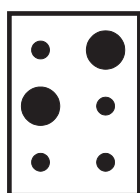
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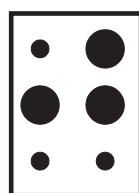
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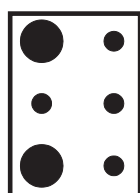
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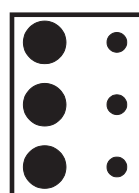
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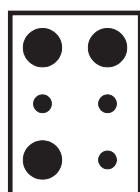
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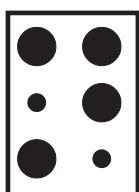
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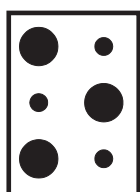
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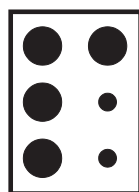
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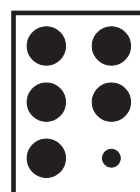
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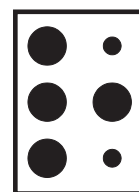
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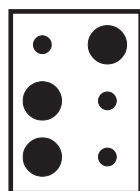
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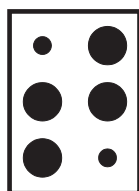
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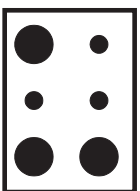
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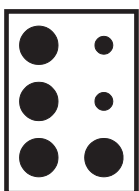
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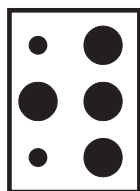
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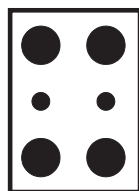
u



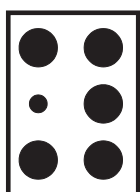
v



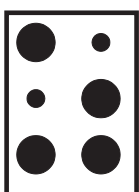
w



x



y



z

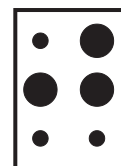
How many letters are made using:

- One raised dot?
- Two raised dots?
- Three raised dots?
- Four raised dots?
- Five raised dots?

Show your results in an organised way.

Name(s):

The English Braille alphabet is based on a grid of six dots.



Some dots are raised so that they can be read by touch.

Investigate patterns that can be made using:

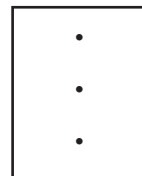
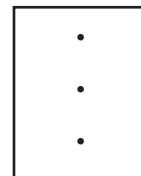
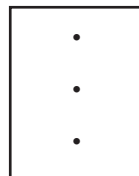
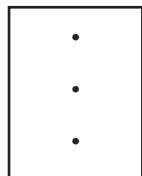
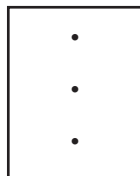
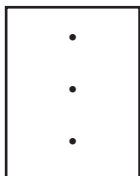
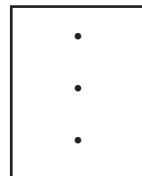
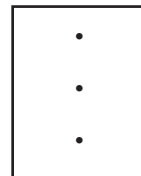
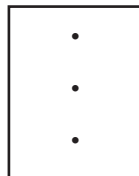
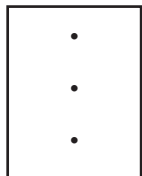
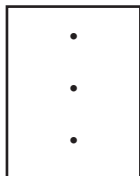
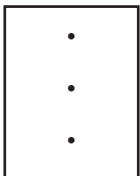
- (i) just one raised dot
- (ii) two raised dots.

Why are only some of these patterns used in Braille?

Name(s):

Make as many different patterns as you can.

You may not need to use all the grids.



Make as many different patterns as you can.

You may not need to use all the grids.

