Bowland maths : Alien invasion

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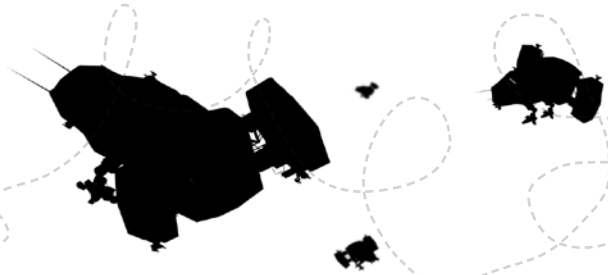

Previous learning

Before they start, pupils should be able to:

- use and interpret coordinates in all four quadrants (level 5);
- recognise simple properties of parallelograms and circles (level 5);
- calculate with decimals, using a calculator where appropriate (levels 4/5);
- solve simple problems involving ratio (level 5);
- identify multiples, square numbers, triangular numbers, powers of 2 (level 5);
- construct, express in symbolic form, and use simple formulae (level 5);
- construct and interpret data in simple line graphs (level 4);
- understand and use the mode and range to describe sets of data (level 4).

Main objectives at NC levels 5 and 6

In this unit, pupils learn to:

- appreciate mathematics as an enjoyable activity;
- use and apply mathematics to solve problems in familiar and unfamiliar contexts;
- appreciate some applications of mathematics;
- recognise that mathematics can be represented in different ways;
- work logically towards results and solutions;
- calculate accurately, using a calculator where appropriate;
- make connections within mathematics;
- estimate, approximate and check working;
- engage in mathematical discussion of results;
- relate findings to the original context;

and to:

Lesson 1
- estimate and calculate using measures in everyday situations (level 5);
- use and interpret maps and scale drawings (levels 5 and 6);
- recognise that all points on the circumference of a circle are the same distance from the centre (level 6);

Lesson 2
- use the mean, median or mode (level 5);
- use all four operations with decimals to two places (level 5);
- solve problems involving direct proportion (levels 5 and 6);

Lesson 3
- discuss and interpret graphs arising from real situations (levels 5 and 6)

Lesson 4
- generate integer sequences (levels 4 and 5);
- find and describe the *n*th term of a sequence (level 6);
- formulate and solve linear equations (level 6).

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Lessons

1 The landing
2 The plan
3 Alien behaviour
4 The escape

About this unit

This unit consists of four lessons of 50 minutes to 1 hour.

The lessons are based on a full-scale alien invasion coinciding with a school visit to a city. The invasion leads to a series of non-routine problems for pupils to solve by working in small groups. The problems are linked to the theme of mathematical communication and are designed to promote discussion, reasoning and creativity. The mathematical topics involved are not always immediately obvious as they are set in an unusual context. However, they are all part of the KS3 mathematics curriculum, mainly at National Curriculum levels 5 and 6. Each lesson ends with a 'cliff hanger' intended to maintain pupils' interest and to lead into homework tasks.

The unit includes these introductory notes, four sets of lesson notes accompanied by animated video and audio clips, slides, resource sheets which include homework tasks, and solutions to the problems. The first homework is essential to the progress of the unit but the rest are optional.

Presenting the unit to pupils

The mathematics in the unit is suitable for pupils working at National Curriculum levels 5 and 6, i.e. pupils of average and above average attainment in Years 8 or 9, and high attaining Year 7 pupils.

The unit can be an opportunity for pupils to apply and use skills that they have previously been taught and to see connections between mathematical topics. In this case, the lessons are best taught consecutively.

Alternatively, the unit can be an opportunity to introduce or extend skills and be taught, say, as one lesson per week for four or more weeks. In this case, the intervening lessons can be used for further teaching and practice.

In classroom trials of Alien invasion, the most engaging and dynamic lessons were those where teachers presented the unit as though it were they and their classes who were making the school visit, using words such as 'you' and 'we' instead of 'they'. The problems became impelling and the pupils were highly motivated to solve them. They felt part of the situation rather than removed from the action.

The pupils' favourite parts of the lessons were the videos, closely followed by the map work and the codes. Here are some of their reactions:

'We worked as a team and it was fun.' (Year 7, set 1)
'The lessons were exciting.' (Year 7, set 1)
'The problems stretch your mind.' (Year 8, set 1)
'The maths wasn't forced – we didn't know what we were learning until we thought about it.' (Year 8, set 1)
'We covered all areas of maths in a fun way.' (Year 8, set 2)
'I would like more lessons like this because they were interactive and a bit of a challenge. It's a better way to learn.' (Year 9, set 2)
'I like doing something different to normal boring lessons.' (Year 9, set 2)
'It's much better than working out of books.' (Year 9, set 3)

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Adapting the lessons

Each set of lesson notes starts by explaining to all teachers how the video, audio and print resources relate to the storyline, and the possible learning points for the lesson. These notes are on a shaded background.

The rest of the lesson notes are a guide to less experienced teachers or teachers from non-conventional backgrounds on the possible flow of the lessons, questions to ask and adaptations of activities for pupils of differing abilities.

However, all teachers should feel free to tailor the lessons, activities and print resources to the particular needs of their classes. For example:

Optional activities

Since lessons vary in duration from one school to another, in all four lessons some activities and resources are optional. These can be omitted if lessons are 50 minutes or less and teachers so wish.

The optional parts of lessons are shown in italics in the lesson notes.

Supplementary problems

The supplementary problems are additional materials for pupils who finish the main tasks quickly. As such, these too are optional.

Differentiated activities

Ideas for simplifying or extending the main problems are given in each lesson plan, including suggestions for the type of support that might be needed.

Homework

The homework tasks, which are designed to reinforce the learning in the lesson, are labelled Task A, Task B and, for lesson 1, Task C. This provides flexibility through options for shorter or longer homework, depending on the school's policy.

All the homework tasks are optional, with the exception of Task A of lesson 1, which involves pupils in gathering data to work out their personal average walking speed. This data is used in lesson 2.

If the supplementary problems have not been tackled in the lessons, these could be offered as an alternative to the homework tasks.

Modifying lesson 1

In trials, a teacher whose pupils were unaccustomed to problem solving decided to adapt the first lesson and homework to form lesson 1a and lesson 1b. This allowed more time for pupils to solve the problems and for teaching of the associated skills. It also ensured that the essential homework was completed by all pupils. This is her description of how she took the final part and homework of lesson 1 to make it into an extra lesson.

> *'In the extra lesson, I played the video clip (Resource 1.8) and gave out copies of the homework sheet (Resource 1.9). We simulated walking through busy streets – we timed a minute twice and counted the number of paces. This enabled pupils to answer the homework questions, which are good questions at an appropriate level.*
>
> *Then everyone entered their speed in mph and km/h into a spreadsheet I had prepared. I showed them how to use the spreadsheet to find the mean, mode and median walking speeds for the class and we discussed which would be best to use, and why. Pupils then worked in their groups with a laptop, and repeated this for their group.*
>
> *I ended the extra lesson by discussing with the class the factors that could affect the average walking speed of an individual person, and then factors that could affect the overall performance for a group of people walking in the same conditions.'*

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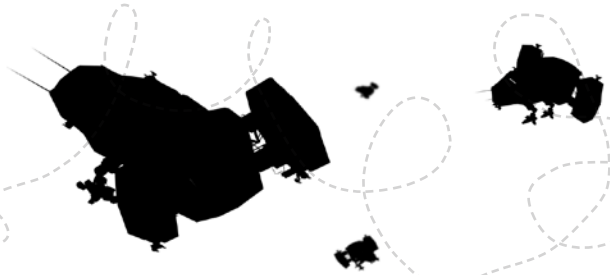

Modifying lesson 4

A few teachers in the trials found that for pupils who are currently working at level 5, the fourth lesson was better if taught over two periods. This allowed them to build in some preliminary teaching or revision of work on deriving formulae and finding the *n*th term of a sequence.

One trial school invited pupils from Years 10 to 12 to support less secure pupils in the fourth lesson. This proved to be a very successful way of making sure that all pupils completed the task and felt a sense of achievement. If you choose to do this, you may need to spend half an hour preparing the support students in how to help and, in particular, the questioning strategies to use.

Cross-curricular opportunities

Lesson	Subject	Topic
1	Geography	Map work; environmental study, e.g. 'Why Aliens chose our planet'
	English	Creative writing about the alien landing
2	ICT	Using LOGO to generate and transform shapes
	PE	Gymnastics; navigating an obstacle course; calculating average walking and running speeds with spreadsheets
	English	Descriptions of the scene
3	Science	Animal behaviour; cooling curves
	CDT	Nutrition analyses
4	Art	Study of patterns
	English	Report writing, e.g. for a radio news broadcast
	ICT	Taking and editing digital photographs, e.g. using Photoshop; using email to send report

Practical resources

for the teacher, whiteboard, data projector and laptop

spreadsheet software (optional)

for pupils, string, ruler, compasses, scissors, calculators, small counters

Key terms and notation

problem, solution, method, pattern, relationship, rule, represent, solve, explain, justify, reasons, reasoning

estimate, approximately, round, decimal place, accuracy, calculate, multiple, product, quotient, scale, scale factor, direct proportion, ratio

units of measurement, metric, imperial, compass directions

graph, linear, straight-line graph, distance-time graph, formula, equation, expression, sequence, term, position-to-term rule, *n*th term

mean, median, mode, data

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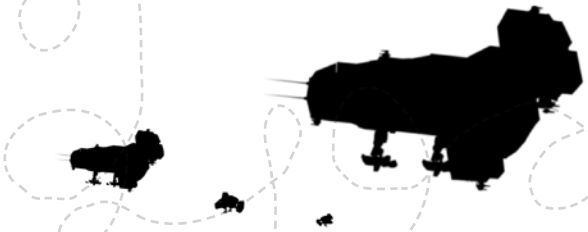

Common errors and misconceptions

- Pupils have no strategies for estimating measurements, such as using benchmarks.
- Pupils choose inappropriate units for making a measurement.
- Pupils don't recognise equivalent ratios, or make errors when they scale quantities up or down.
- Pupils think that increasing a map scale increases the map distance rather than decreasing the map distance.
- Pupils misinterpret the scale on an axis of a graph, or think that a positive gradient on a graph represents 'going up hill'.
- Pupils don't distinguish between sketching a graph and drawing it accurately.
- Pupils confuse term-to-term rules and position-to-term rules for sequences.

Assessment

You could present the objectives for the unit worded in pupil-friendly language for pupils to make a self-assessment of the progress that they think they have made.

For the final homework, some suggestions are made for relevant National Curriculum test questions. You could ask pupils to try a selection of these questions to help you and them to judge how effective their learning has been.

Useful websites

Secondary Strategy resources, including Framework:
www.standards.dfes.gov.uk/keystage3/

UFOs
news.bbc.co.uk/1/hi/uk/4981720.stm
en.wikipedia.org/wiki/UFOs
homepage.ntlworld.com/mjpowell/ufo.htm

Average walking speeds
www.go4awalk.com/navigationskills/timing.php
www.routehiker.org.uk/statistics.php
www.comp.leeds.ac.uk/kwb/ENV/conf_draft/sc06lcn.pdf

Road traffic speeds
www.dft.gov.uk/pgr/statistics/datatablespublications/roadstraffic/speedscongestion/

Pascal's and Sierpinski's triangles
mathforum.org/dr.math/faq/faq.pascal.triangle.html
math.rice.edu/~lanius/fractals/pas2.html

Fibonacci
www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/fibnat.html

Codes and cryptography
en.wikipedia.org/wiki/Codes