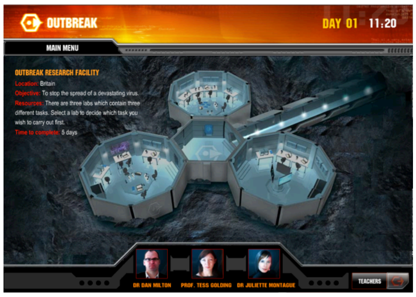
BOWLAND
MATHS
Assessing the Case Studies

Outbreak
Assessing the learning

Case Study description

Pupils work to contain the spread of a deadly disease.



Suitability National Curriculum levels 4 to 8

Time The assessment activities are part of the Case Study and can be done within the time for it.

An optional assessment activity (page 8) is linked to, but not part of, the case study; it could be used to challenge able pupils during the initial phases of the Case Study. It could be undertaken for homework.

Resources All activities are based on materials already within the Case Study.

Opportunities to assess Key Processes

- **Representing**: during lessons 1, 2, 3 and the optional activity
- **Analysing**: during lessons 2, 3 and the optional activity
- **Interpreting and evaluating:** during lessons 1, 2, 3 and the optional activity
- **Communicating and reflecting**: during lesson 3 and the optional activity

In addition to assessment of the Key Processes, there are opportunities to assess Range and Content (detail is given in the Case Study) and some of the other personal, learning and thinking skills, particularly for 'team working'.

In trials, pupils presented their findings, providing further opportunities to assess Process Skills.

Lab 01: Infection Detection

Pupils analyse and interpret information to identify the location of infected people.

Teacher guidance

Option 1 offers the greatest opportunities for assessing the Key Processes.

Observe how well pupils:

- Develop a strategy
- Work logically

Option 1: Identifying the location of infected people

Questions to ask:

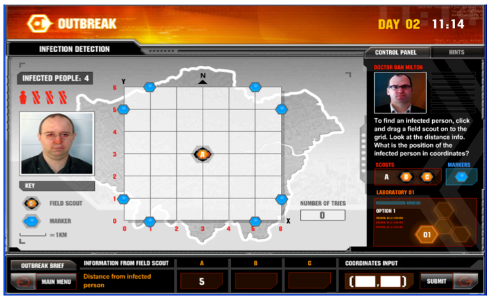
- *How did you decide where to place your first scout?*
- *What did you do next?*
- *What strategies did you use to become more efficient?*

Assessment guidance: Progression in Key Processes

	Representing	**Interpreting and evaluating**
PROGRESSION ↓	Places the scouts randomly on the grid	Using two scouts, identifies different possible locations for the infected person
	Develops a simple strategy, eg identifies alternatives when positioning a scout and considers implications Pupil A	Explains a strategy Pupil A
	Develops a strategy, eg places the first scout in a corner so that markers can be positioned quickly	Explains a strategy and considers its efficiency
	Develops an efficient strategy, eg places the first scout in a corner, then places the second scout in such a way that it is not equi-distant from any markers Pupil B	Explains an efficient strategy and uses mathematical reasoning to justify its efficiency Pupil B

Sample response: Pupil A

Comments



Pupil A's strategy was to place his first scout in the centre of the grid. He explained this enabled him to use symmetry when placing markers and to ensure that the infected person is never more than 6 units away. However, he placed the second scout at random.

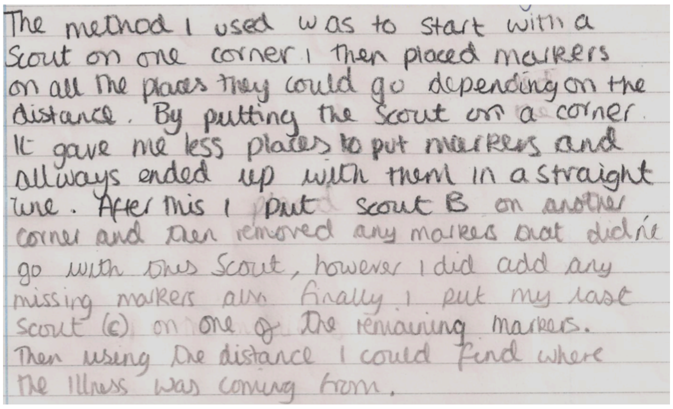
Probing questions and feedback

- *Using the diagram shown here, can you explain why it would be more sensible to place the second scout at (0, 2) rather than at (0, 3)?*
- *Where else would it not be sensible to place the second scout, and why?*

Pupil A would benefit from comparing his strategy with others, discussing which are most efficient and why

Sample response: Pupil B

Comments


The method I used was to start with a Scout on one corner, Then placed markers on all the places they could go depending on the distance. By putting the Scout on a corner It gave me less places to put markers and allways ended up with them in a straight line. After this I put Scout B on another corner and then removed any markers that didn't go with this Scout, however I did add any missing markers also. Finally I put my last Scout (C) on one of the remaining markers. Then using the distance I could find where the illness was coming from.

Pupil B decided on an efficient strategy to place her first scout. In discussion, she confirmed that the choice of corner for the second scout matters since 'if you place it diagonally opposite it's the same distance to two places, but for the other corners each marker is always a different distance away so you can find the infected person'.

Probing questions and feedback

- *Does your strategy always allow you to find an infected person using just two scouts? Why not?*
- *Can you work out the probability of finding an infected person using just two scouts?*

Pupil B would benefit from working on complex tasks that require efficient and effective strategies.

Lab 02: Super Antidote

Pupils look for the best combination of ingredients for an antidote

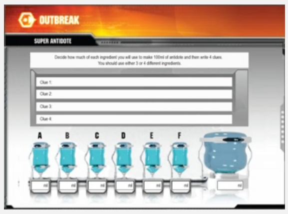
Teacher guidance

The best opportunities for assessing Key Processes are in the homework options in which pupils devise their own clues to produce an antidote (see the supporting worksheets in the detailed teacher's resource).

Before starting, pupils could discuss and agree what would make a good set of clues. Completed work can then be exchanged and evaluated against the agreed success criteria.

Observe how well pupils:

- Write relevant clues
- Write a coherent set of clues for the production of an antidote
- Review other pupils' solutions and make suggestions for improvement



Homework option (could be undertaken in class)
Design your own antidote

Questions to ask:

- *Are all your clues needed to find the antidote? Are any not necessary?*
- *What would make your clues easier / more challenging?*
- *How would you evaluate your clues against the agreed success criteria?*

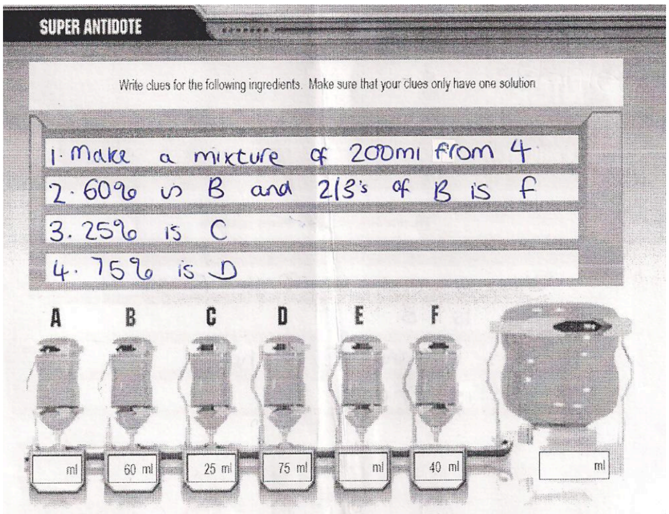
Assessment guidance: Progression in Key Processes

	Representing	**Analysing**	**Interpreting and evaluating**
PROGRESSION ↓	Uses only limited mathematical content eg fractions or simple operations	Mostly creates and answers simple clues correctly Pupil C	Gives accurate feedback to others, even if simple Pupil C, Pupil D
	Uses a range of mathematical content, even if based on work already seen Pupil C, Pupil D	Creates and answers clues correctly, using a range of mathematical content Pupil D	Gives accurate feedback, making helpful suggestions for improvement
	Selects other areas of mathematics when creating own clues, eg uses algebra	Creates and answers clues correctly, using a wide range of mathematical content	Shows insight as to why some solutions are 'better' than others
	Creates relevant, varied and demanding clues	Creates and answers demanding clues correctly, using a wide range of mathematical content	Reviews effectively, and supports the understanding of others

Sample response: Pupil C

Comments

Pupil C used percentages and simple fractions. Her review and feedback to others showed that she could create and answer simple clues but that she consistently confused volumes and percentages.



Probing questions and feedback

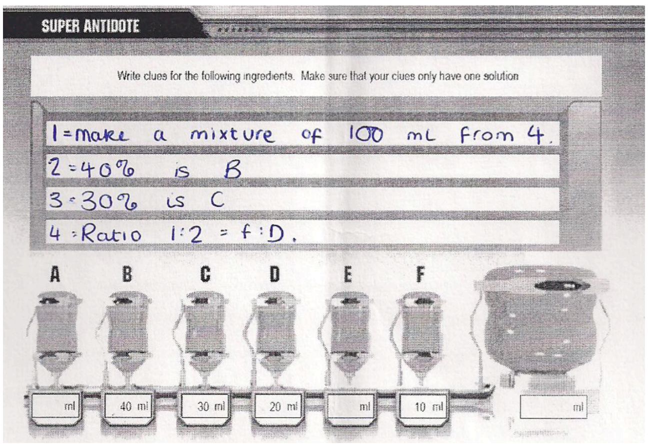
- *What does 100% mean? How does that help you to see that your percentages must be wrong?*

Pupil C would benefit from working on tasks based on real-life contexts. This would help her when reviewing her findings to check that they make sense within the context.

Sample response: Pupil D

Comments

Pupil D solved this simple problem using percentages and ratio. When reviewing others' work, he answered more demanding clues correctly, though his feedback to them was limited to identifying errors.



Probing questions and feedback

- *Think about how you have presented your clues. Why might some people find your clues a little confusing? How could you make them clearer?*

Pupil D would benefit from class discussion of work from a range of pupils. This would support him in identifying strengths and weaknesses within his and others' work.

Lab 03: Strategic Planning

Pupils decide how to allocate vaccines to different subgroups of the population.

Teacher guidance

In trials, pupils also presented their findings as this provided further opportunities to assess Process Skills.

Spreadsheet Activity: Allocating vaccines

Observe how well pupils:

- Use a spreadsheet
- Optimise their solution
- Justify their answers

Questions to ask:

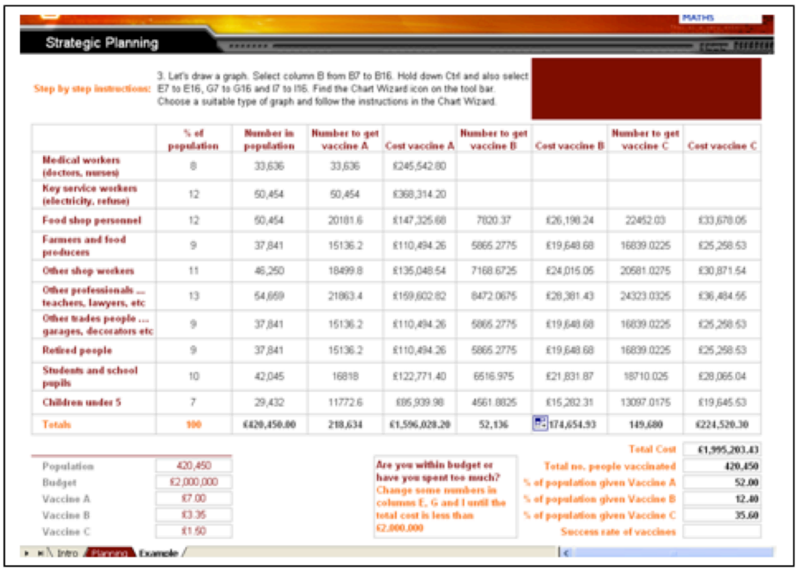
- *How did you decide the number of people in each category to be given the vaccines?*
- *How did you use the spreadsheet? What formulae did you use and how?*
- *What are the likely consequences of the decisions you've made?*
- *How would you present your decisions? Why?*

Assessment guidance: Progression in Key Processes

	Representing	**Analysing**	**Interpreting and evaluating**	**Communicating and reflecting**
PROGRESSION	Varies values when trying to find a solution	Needs support to enter and interpret formulae	Checks then improves values	Writes or talks about findings; thinks of simple ways to improve performance
	Varies values systematically when trying to find a solution	Enters and interprets some formulae without support	Explores the effects of varying spreadsheet entries	Communicates clearly and effectively; identifies improvements
	Chooses an effective strategy, eg uses proportions when varying values Pupil pair E	Enters and interprets formulae without support	Explores in a structured manner the effects of varying spreadsheet entries Pupil pair E	Communicates clearly and effectively and reflects on efficiency Pupil pair E
	Chooses an effective and efficient strategy	Enters and interprets formulae efficiently and effectively Pupil pair E	Justifies own solution as optimal	Reports and justifies findings clearly and effectively

Sample response : Pupil pair E

We gave the really important people vaccine A because they are going to be needed and we want most of them to survive and they get 95% so most will be ok. For everyone else we decided it would be fair to give 50% of the population vaccine A so that we can do it at random with one in two getting it and then we gave vaccine B to three tenths of them and everyone else got vaccine C. We used formulae to work things out quick but we spent too much. We had to save about 200K so we gave 40% to A then we kept changing B and C till we got just under the money so B got 15.5% and C gets 44.5% making 100% so everyone gets something so they get a chance to survive.



	% of population	Number in population	Number to get vaccine A	Cost vaccine A	Number to get vaccine B	Cost vaccine B	Number to get vaccine C	Cost vaccine C
Medical workers (doctors, nurses)	8	33,636	33,636	£245,542.80				
Key service workers (electricity, refuse)	12	50,454	50,454	£368,314.20				
Food shop personnel	12	50,454	20181.6	£147,325.68	7820.37	£26,198.24	22452.03	£33,678.05
Farmers and food producers	9	37,841	15136.2	£110,494.26	5865.2775	£19,648.68	16839.0225	£25,258.53
Other shop workers	11	46,250	18499.8	£135,048.54	7168.6725	£24,015.05	20581.0275	£30,871.54
Other professionals ... teachers, lawyers, etc	13	54,659	21863.4	£159,602.82	8472.0675	£28,381.43	24323.0325	£36,484.55
Other trades people ... garages, decorators etc	9	37,841	15136.2	£110,494.26	5865.2775	£19,648.68	16839.0225	£25,258.53
Retired people	9	37,841	15136.2	£110,494.26	5865.2775	£19,648.68	16839.0225	£25,258.53
Students and school pupils	10	42,045	16818	£122,771.40	6516.975	£21,831.87	18710.025	£28,065.04
Children under 5	7	29,432	11772.6	£85,939.98	4561.8825	£15,282.31	13097.0175	£19,645.53
Totals	100	£420,450.00	218,634	£1,596,028.20	52,136	174,654.93	149,680	£224,520.30

Population	420,450
Budget	£2,000,000
Vaccine A	£7.00
Vaccine B	£3.35
Vaccine C	£1.50

Are you within budget or have you spent too much? Change some numbers in columns E, G and I until the total cost is less than £2,000,000

Total Cost	£1,995,203.43
Total no. people vaccinated	420,450
% of population given Vaccine A	52.00
% of population given Vaccine B	12.40
% of population given Vaccine C	35.60
Success rate of vaccines	

<u>What was good?</u> We worked together and agreed our strategy and we didn't argue. We <u>What would we change?</u> You can't have decimal people but we weren't sure how to do that. We thought we had got the best plan but Miss showed us how to work out the success rate for everyone and someone else got better than us so we would look to see how to make it better next time. And we ran out of time so didn't draw a graph.

Comments

The pupils worked efficiently and effectively. They explained and improved their strategy and reflected on their work.

Probing questions and feedback

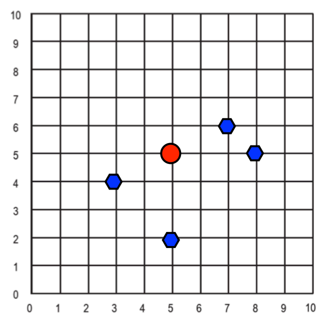
- *What would have been the advantages of drawing a graph?*
- *If you were starting the task again, what strategy would you adopt and why?*

Pupil pair E would benefit from discussing with other pupils the pros and cons of a range of strategies and solutions. This should help them in thinking about optional solutions when they engage with other tasks.

Optional activity: How many locations?

To provide further assessments for Process Skills, this activity builds on the work done in Lab 01: Infection Detection.

How many locations?



What do these hexagonal points have in common?

How many points are 3km from the centre of the grid – going along the grid lines? How many are 2km away? … 4km away? Can you find a pattern in your results?

Try to explain why the pattern occurs and predict what would happen for other distances.

Extension activity: In total, how many points are 3km or less away from the centre of the grid?
Or 2km or less away? … Or 4km or less away ….. ?

Assessment guidance: Progression in Key Processes

	Representing	Analysing	Interpreting and evaluating	Communicating and reflecting
PROGRESSION	Uses diagrams effectively	Works systematically	Makes a prediction based on results	Writes or talks about findings; communicates clearly
	Sets out work clearly, eg uses a table of results	Draws together results, noting term-to-term patterns	Makes and tests a prediction based on results	Draws accurate and useful conclusions
	Uses diagrams, words and symbols	Draws together results, noting simple position-to-term relationships, even if expressed in words	Seeks to justify results Pupil F	Draws accurate and useful conclusions, reflecting on other approaches
	Uses diagrams, words and symbols effectively Pupil F	Draws together results, noting position-to-term relationships Pupil F	Shows mathematical insight by justifying findings	As above and notes connections to other work, eg recognises similar structures Pupil F

Sample response: Pupil F

Comments

Pupil F used his mathematical understanding to find algebraic formulae that describe both scenarios.

Probing questions and feedback

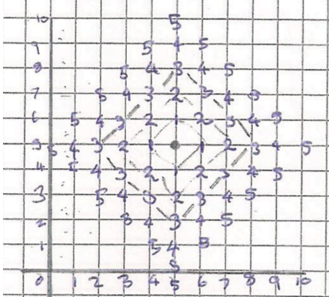
- *Now that you have found the formulae, can you see a way in which you could have used the structure of the problem to get to the solution in a different way?*

Pupil F would benefit from using structure to establish generality since this will support him when justifying his findings.

Investigating Infection locations.

I am trying to find out ~~how many~~ a rule describing how as the distance increases, so does the number of locations away from a fixed point.

I decided to begin by drawing a grid and finding out how many different locations are 1km. I will then work methodical and increase the distance by 1 each time as this will make patterns easier to notice.



This diagram shows how the number of locations increased each time. It also shows that the equidistant points create square shapes. Below is a table showing my results and how this increased each time.

Distance (km)	Number of locations	Increase
1	4	~~4~~
2	8	+ 4
3	12	+ 4
4	16	+ 4
5	20	+ 4
D	L=4D	N/A

This table makes it clearer to see how it increases each time by 4.

Using this I can work out that the formulae for the pattern is L=4D.

I checked this by using the calculations 1×4=4, 2×4=8, 3×4=12, etc. I can then use the formulae to work out any distan

I was then asked to work out how many locations were a distance or less. I already knew that this would involve adding on the previous result as it would be cumulative frequency. I also decided to use the diagram above and draw a results table to use to create a formulae.

Distance (km)	Number of locations	Increase	Change of increase
1	4		
2	12	+ 8	+ 4
3	24	+ 12	+ 4
4	40	+ 16	+ 4
5	60	+ 20	+ 4
D			

Using this table I can see that although the number of locations increase changes each time, this consistently increases by 4.

I know that the formulae must begin with $2D^2$ but I do not know what to add or subtract from the end. I then drew a table to help see this.

~~Location~~ Distance	$2D^2$	what I need to add.
~~4~~ 1	2	2
~~12~~ 2	8	4
~~24~~ 3	18	6
~~40~~ 4	32	8
~~60~~ 5	50	10

Looking at this table I noticed the number needed to be added was always double the ~~num~~ Distance.

I now know that the formulae must be $2D^2+2D$.