

## **EXPLORERS – PATROL SERVICES**

The activities are designed for 60-minute lessons. You may need to adapt the materials for use in longer or shorter lessons.

### **INTRODUCTION**

In this activity, pupils are invited to find a safe route through a notoriously perilous region of space called the Twilight Nebula. They will be faced with a number of different threats but can maximise their chances of survival using a series of threat assessment readouts.

Pupils will compare fraction, decimal and percentage-based probabilities to evaluate the threats arising in the nebula. They will also need to form judgements on the probability of combined events in order to identify those routes offering the greatest chance of survival.

This activity is mainly ICT-based.

### **LEARNING OBJECTIVES**

Pupils will:

- use mathematical problem solving skills in collaboration with each other
- use the multiplicative law of probability in combined events
- use an experimental method to find an estimate of a probability.

### **LEARNING OUTCOMES**

Most pupils will:

- collaborate within their groups to address the problem
- compare probabilities in different forms using mental or pencil and paper methods
- emerge with a final survival rate around the set target
- evaluate their strategies and report back to the class.

Pupils making slower progress will:

- collaborate within their groups to address the problem
- compare probabilities in different forms using calculator methods
- emerge with a final survival rate working towards the set target
- evaluate their strategies and report back to the class.

Pupils making faster progress will:

- collaborate within their groups to address the problem
- compare probabilities in different forms using mental methods
- emerge with a final survival rate exceeding the set target
- evaluate their strategies and report back to the class.

### **NATIONAL CURRICULUM OBJECTIVES**

#### **Ma4 Handling data**

#### **Using and applying handling data**

1) Pupils should be taught to:

- d) review progress as they work; check and evaluate solutions
- h) apply mathematical reasoning, explaining and justifying inferences and deductions.

**Processing and representing data**

4) Pupils should be taught to:

- d) understand and use estimates or measures of probability from theoretical models, including equally likely outcomes, or from relative frequency.

**Interpreting and discussing results**

5) Pupils should be taught to:

- h) use the vocabulary of probability in interpreting results involving uncertainty and prediction
- i) compare experimental data and theoretical probabilities
- j) understand that if they repeat an experiment, they may - and usually will - get different outcomes, and that increasing sample size generally leads to better estimates of probability and population characteristics.

Links to the revised Programme of Study for introduction in 2008 include:

**1 Key concepts****Creativity**

- b) Using existing mathematical knowledge to create solutions to unfamiliar problems.

**Applications and implications of mathematics**

- b) Understanding that mathematics is used as a tool in a wide range of contexts.

**2 Key processes****Representing**

Pupils should be able to:

- a) identify the mathematical aspects of a situation or problem.

**Analysing**

Pupils should be able to:

- b) use knowledge of related problems
- g) take account of feedback and learn from mistakes
- l) calculate accurately, selecting mental methods or calculating devices as appropriate.

**3 Range and content****Number and algebra**

The study of mathematics should include:

- a) rational numbers, their properties and their different representations.

**Statistics**

The study of mathematics should include:

- d) experimental and theoretical probabilities, including those based on equally likely outcomes.

#### **4 Curriculum opportunities**

The curriculum should provide opportunities for pupils to:

- a) develop confidence in an increasing range of methods and techniques
- e) work on tasks that bring together different aspects of concepts, processes and mathematical content
- f) work collaboratively as well as independently in a range of contexts.

#### **LESSON PREPARATION**

- Read the teacher notes and familiarise yourself with the other materials.
- Ensure that the activity is available to use on your teacher laptop or desktop computer.
- Ensure that the activity is available for pupils to use, e.g. via school network.
- Arrange for access to an ICT suite.
- Print off enough copies of the accompanying activity sheets.
- You may wish to create a certificate of achievement for pupils that perform well.

#### **Vocabulary**

Event, outcome, probability, experimental probability, theoretical probability, frequency, relative frequency.

#### **Materials required**

You will need:

- Teacher laptop or desktop computer (to introduce activity)
- Data projector (to introduce activity)
- Access to an ICT suite with enough computers for pupils to work in small groups
- Printed copies of the accompanying activity sheets
  - Captain's Log Sheet
  - Mission Results Sheet
- Calculators (optional)

#### **Prior knowledge and skills**

Pupils should already:

- be able to convert decimals and percentages to fractions
- be confident in multiplication of fractions.

#### **Health and Safety**

All standard safety procedures with computers need to be in place.

Further information can be found at <http://schools.becta.org.uk>

#### **LESSON DETAILS**

##### **Starter Activity**

Project the starter activity onto a whiteboard.

Ask pupils in their groups to list all the ways the coin and the die can land.

Establish that there are 12 possible outcomes.

Discuss the probability of getting a head.

Pupils should be able to answer this question using their list of outcomes.

$$\frac{6}{12} = \frac{1}{2}$$

Discuss the probability of getting a six.

Again, pupils should be able to answer this question using their list of outcomes.

$$\frac{1}{6}$$

Discuss the probability of getting both a head AND a six.

$$\frac{1}{12}$$

Ask pupils to consider the connection between the previous probabilities.

Write the following incomplete calculation on the board.

$$\frac{1}{2} \quad \frac{1}{6} = \frac{1}{12}$$

Ask pupils to identify the operation that is required to make it correct (multiplication).

Annotate the board to show this.

$$\frac{1}{2} \times \frac{1}{6} = \frac{1}{12}$$

Discuss the probability of getting either a head OR a six OR both.

$$\frac{7}{12}$$

Ask pupils to consider the connection between the previous probabilities.

Write the following incomplete calculation on the board.

$$\frac{1}{2} \quad \frac{1}{6} \quad \frac{1}{12} = \frac{7}{12}$$

Ask pupils to identify the operations that are required to make it correct (addition and subtraction).

Annotate the board to show this.

$$\frac{1}{2} + \frac{1}{6} - \frac{1}{12} = \frac{7}{12}$$

If time allows, ask the pupils some follow-up questions.

- What is the probability of getting a tail?
- What is the probability of getting a number bigger than 2?
- What is the probability of getting a tail AND a number bigger than 2?
- What do you notice if you multiply the first 2 answers?

Lead into the main activity (see below).

### Main Activity

The aim of this activity is to find a safe route through the perilous Twilight Nebula.

The nebula is divided into sectors each containing a different combination of potential threats.

The probability of each threat arising varies greatly from sector to sector.

Pupils will need to:

- assess the likelihood of each threat arising along their chosen route
- customise their ship's defences to counter the potential impact of each threat.

Pupils will receive 'special recognition' if they can:

- find a route offering at least a 50% chance of survival over 20 attempts\*.

\*We suggest 20 attempts but you may choose to do more or less than this.

This activity is based around an open problem with a complexity of potential interpretations.

Opportunities for discussion and group presentations have been incorporated into the activity.

Pupils should be arranged in small groups at a computer.

With mixed ability classes, try to ensure that each group has an appropriate mix of pupils.

This will help to create appropriate conditions for peer support.

Each group should be given:

- a copy of the 'Captain's Log' sheet
- a copy of the 'Mission Results' sheet.

Introduce the activity by projecting it onto a whiteboard.

Set the scene using the introductory narrative and the Captain's Log sheet to help.

Refer pupils to the 'Getting Started' section on the Captain's Log sheet.

This fleshes out the narrative a little more and provides an introduction to the activity interface.

Allow time for pupils to experiment with the activity as directed.

Once ready, refer pupils to the 'Discussion Time' section on the Captain's Log sheet.

Ask pupils to consider the questions listed.

Allow time for pupils to discuss their thoughts and define their strategies.

Try to circulate between groups listening to discussion and asking questions as required.

Encourage pupils to pursue their strategies and to develop the mathematics involved.

Take care, however, not to overly direct the pupils.

Once ready, refer pupils to the 'Recording Your Results' section on the Captain's Log sheet.

Before they can launch, pupils will need to define:

- their preferred route across the map
- their preferred power settings for the front shields, rear shields and life support systems.

Once ready, pupils can click the 'Launch ship' button to proceed.

Once launched, the ship will automatically follow the path that has been defined.

Pupils will be able to track the progress of their ship as it moves across the map.

The ship will sustain damage depending on the number and type of threats that arise.

The ship will be destroyed if the front shields, rear shields or life support systems fall to 0.

Pupils will receive feedback after each attempt based on:

- whether the ship survived or was destroyed
- the status of their front shields, rear shields and life support systems
- the number of power points lost to each type of threat

**Ensure that pupils record their results each time in the table on the Mission Results sheet.**

Ask pupils to update their survival rate after each attempt.

Pupils should repeat the process until the 'Mission Results' table is complete.

Pupils can then determine if they are deserving of the 'special recognition' award.

Once ready, refer pupils to the 'Finishing Off' section on the Captain's Log sheet.

Ask pupils to consider the questions listed.

Allow some time for pupils to discuss their thoughts and reflect on their performance.

If time allows, ask pupils to repeat the process, refining their original strategies.

Lead into the plenary activity (see below).

## **Plenary**

Draw the class together and ask the class to reflect on the activity.

Ask each group to report back on their progress, specifically:

- their chosen route and power settings
- their overall survival rate.

Ask selected groups to describe and evaluate the strategies they used.

In particular, ask them to identify what they would do differently next time.

If time allows, ask pupils some follow-up questions such as:

- What was the key to success in this activity?
- Why did the same route and power settings produce different outcomes each time?

Finally, ask the class to consider the maths that they have used during the activity.

Ask the class to identify real-life contexts where people may use similar maths.

### **Homework Suggestions**

Ask pupils to ensure that they have completed their Captain's Log reflecting on their results and evaluating their performance during the activity as required.

Additionally, pupils could be invited to complete the accompanying homework task sheet. This gives further practice in calculating the probability of combined events.

### **TECHNICAL SUPPORT**

This activity makes use of Flash and Adobe PDF files. To access all the resources that are provided, you will need the minimum machine and software specifications as listed below.

Adobe Flash Player (previously known as Macromedia Flash Player) is required to launch the activity. The latest version of Flash and guidance on how to use it can be downloaded from:

[http://www.adobe.com/shockwave/download/download.cgi?P1\\_Prod\\_Version=ShockwaveFlash](http://www.adobe.com/shockwave/download/download.cgi?P1_Prod_Version=ShockwaveFlash)

Adobe Reader or Distiller is required to view these notes. The latest version of Reader and guidance on how to use it can be downloaded from:

<http://www.adobe.com/products/reader/>

### **Minimum Machine and Software Specifications**

#### **PC**

P3 800MHz

128MB RAM

Windows 2000

Screen resolution 1024 x 768

Microsoft Internet Explorer 5.5, Firefox 1, Netscape 7 or Opera 7

Macromedia Flash Player 7

Adobe Reader 7

**Mac**

G3 500MHz

128MB RAM

OS X 10.2

Screen resolution: 1024 x 768

Safari 1, Firefox 1, Netscape 7, or Opera 6.2

Macromedia Flash Player 7

Adobe Reader 7