Global and community health

Probability and immunity

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feel better
live longer

Educator notes

Learning objectives

- Expressing probability using the probability scale
- Expressing the probability of a given event using fractions, decimals and percentages
- Calculating the probability of simple events
- Being able to record, describe and analyse the frequency of outcomes of simple probability experiments, using appropriate language
- Interpreting sample spaces for single and combined events
- Understanding the concept of herd immunity

Curriculum links

- Maths
  - Number
  - Statistics
  - Probability
  - Algebra
  - Working mathematically

Resources required

- Probability and immunity presentation slides

Equipment needed

Per two students:

- Calculator
- Dice (2)
- Coloured counters (50 green, 50 red, 50 blue)
- Paper, pencils, rulers

Time needed: 60 minutes

Prior knowledge required

To complete this module students will need to already have a basic understanding of:

- How to calculate probability
- Using fractions, decimals and percentages to express probability

Contents

Contents	Page
Calculating probability (10 mins)	2
Activity 1: Experimental probability (25 mins)	2
Activity 2: Experimental probability in practice (20 mins)	3
Plenary (10 mins)	3

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In this lesson, students will explore probability through the lens of vaccines and immunity. They will use judgement to make predictions about events, use a probability scale to assign numerical values to these judgements, practise converting values between fractions, decimals and percentages, predict the outcome of planned experiments, and create an experimental model to calculate probabilities around a virus in a given population.

Slides 1-5
Introducing calculating probability

- Introduce the topic of this lesson, telling the class they will be exploring probability through the lens of vaccines and immunity
- Recap the probability equation using **Slide 2**: explain that the probability of an outcome equals the number of ways the outcome can happen, divided by the total number of possible outcomes
- Check students' understanding of using this equation by explaining the example of tossing a coin on **Slide 3**
- Further ask students to calculate the probability of the scenarios given on **Slide 4**
- Move to **Slide 5** to show the answers. Ensure students understand how to get the right answer using this equation before moving on

Slide 6-9
Experimental probability

Activity 1
Experimental probability

25 mins

- Explore the limits of purely theoretical probability using dice by asking students to carry out the short experiment on **Slide 7** and see if they can predict the outcome of rolling a dice accurately
- Students should roll dice six times, and discuss their results
- Move to **Slide 8** and ask students to make predictions for questions 1-4 in their notebooks, and answer the question on the slide
- Students should then test prediction 1 and roll a dice 30 times, and record how many 3s they roll (If time permits, you could test predictions 2-4 as well, or multiple tests at 30 rolls)
- Move to **Slide 9** and discuss results in comparison to the predictions
- Further explain that the prediction for 300 rolls is likely to be the most accurate, and if an experiment is repeated, the results are not necessarily the same each time. However, it is more likely that the average number of 3s rolled will be closer to the predicted outcome

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Slide 10-16
Experimental probability in practice

Activity 2
Experimental probability in practice

20 mins

- Discuss a possible practical application of experimental probability in public health by introducing the concept of herd immunity using **Slide 10**
- Move to **Slide 11** and introduce the 'Virus X' scenario - a new virus outbreak has occurred in a contained population of 50
- Put students into pairs and distribute counters. If you do not have counters available, you may need to put students in groups or do this task as a class
- Support students in the task on **Slides 12 and 13**, which ask students to conduct a series of experiments to model various vaccination scenarios

Discussion question: What was the impact of more people being vaccinated?
Answer: Move to **Slide 14** to show the answer: When more people are vaccinated, even some of the healthy, unvaccinated people are protected from Virus X. Explain that this is known as herd immunity.

- Using the instructions on **Slide 15**, students should try and find the threshold for herd immunity
- Make sure students understand that whilst their results should be similar to each other, they are likely to differ slightly
- Once the class have completed several successful experiments (less than 10 blue counters at the end), move to **Slide 16**
- Direct students to calculate the average (mean) number of red, green and blue counters present at the end of the experiment
- Ask students to use the averages from the data they collected to calculate the probability of events given on **Slide 16**; the probability that any one person has virus X, and the probability that any one person is vaccinated against it

Slide 17
Plenary

- Recap the probability calculation and the importance of experimental probability by discussing the questions as a class on **Slide 17**

Extension/homework

- Discuss the difficulties the class faced in calculating the threshold for herd immunity, explore the limitations of the experiment, how it could be improved