**Egg roulette: Part 1**

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| Year levelStrand(s)Lesson lengthCD code | * Year 9
* Probability
* 60 mins
* [AC9M9P01](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-9/content-description?subject-identifier=MATMATY9&content-description-code=AC9M9P01&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=3&subjects-start-index=0&view=quick), [AC9M9P02](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-9/content-description?subject-identifier=MATMATY9&content-description-code=AC9M9P02&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=3&subjects-start-index=0&view=quick) and [AC9M9P03](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-9/content-description?subject-identifier=MATMATY9&content-description-code=AC9M9P03&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=3&subjects-start-index=0&view=quick)
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| Lesson summary | Smashing good fun learning about probability without replacement, by playing and exploring the game of egg roulette – 12 eggs, 3 raw and 9 cooked. Contestants take it in turns to choose an egg and smash it on their head hoping to avoid the 3 raw eggs! |
| **Learning intention** | * We are learning to understand probability without replacement.
* We are learning to analyse compound events visually and numerically.
* We are learning to understand the changing probabilities at each stage, including by simulation.
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| **Success criteria** | By the end of this lesson, students can: * correctly identify how probabilities change at different stages in a without replacement probability experiment
* use an array to find probabilities for two-stage compound events
* conduct repeated chance simulations
* calculate relative frequencies from collected data to estimate probabilities involving ‘and’ and ‘or’ statements.
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| **Why are we learning about this?** | Understanding probability is foundational in mathematics, aiding progression to advanced statistics topics. It intertwines with real-world scenarios, enriching our decision-making and analytical skills. Examples include in genetics, where trait inheritance follows probability patterns, and in card games where the odds may change with every card drawn. Understanding changing probabilities helps us comprehend the world and make informed decisions. |
| **Prerequisite knowledge and language** | Key language: compound event with and without replacement, simulation, two-stage compound event, relative frequency, ‘and’ and ‘or’ statements, ‘inclusive or’ and ‘exclusive or’ statements. |
| **Resources** | * Teacher’s slides (PowerPoint)
* Egg-cellent worksheet (Word)
* Teacher’s notes (Word)
* [Egg roulette video](http://www.mathematicshub.edu.au/search/egg-roulette/)
* Calculators, laptop/access to computers for all students
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Curriculum information

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| Achievement standard | By the end of Year 9, students determine sets of outcomes for compound events and represent these in various ways, assign probabilities to the outcomes of compound events and design and conduct experiments or simulations for combined events using digital tools. |
| Content description(s) | * Students list all outcomes for compound events both with and without replacement, using lists, tree diagrams, tables or arrays; assign probabilities to outcomes. [AC9M9P01](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-9/content-description?subject-identifier=MATMATY9&content-description-code=AC9M9P01&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=3&subjects-start-index=0&view=quick)
* Students calculate relative frequencies from given or collected data to estimate probabilities of events involving ‘and’, inclusive ‘or’ and exclusive ‘or’. [AC9M9P02](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-9/content-description?subject-identifier=MATMATY9&content-description-code=AC9M9P02&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=3&subjects-start-index=0&view=quick)
* Students design and conduct repeated chance experiments and simulations, using digital tools to compare probabilities of simple events to related compound events, and describe results. [AC9M9P03](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-9/content-description?subject-identifier=MATMATY9&content-description-code=AC9M9P03&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=3&subjects-start-index=0&view=quick)
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| General capabilitiesCross-curriculum priority | Numeracy progression * Probabilistic reasoning ([Level 6](https://v9.australiancurriculum.edu.au/f-10-curriculum/general-capabilities/numeracy/slideout?code=NSUnC6&element=2&sub-element=0))

Digital literacy* Acquire and collate data ([Level 6](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-9/content-description?subject-identifier=MATMATY9&content-description-code=AC9M9P03&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=3&subjects-start-index=0&view=quick&cdref=Elaboration))
* Interpret data ([Level 6](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-9/general-capability-snapshot?subject-identifier=MATMATY9&content-description-code=AC9M9P03&general-capability-code=DL&element-code=DLI&sub-element-index=1&sub-element-code=DLIC&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=3&subjects-start-index=0&view=quick))

Critical and creative thinking: * Draw conclusions and provide reasons ([Level 6](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/mathematics/year-9/general-capability-snapshot?subject-identifier=MATMATY9&content-description-code=AC9M9P03&general-capability-code=DL&element-code=DLI&sub-element-index=1&sub-element-code=DLIC&detailed-content-descriptions=0&hide-ccp=0&hide-gc=0&side-by-side=1&strands-start-index=3&subjects-start-index=0&view=quick))
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| Areas of challenge | * Students may believe that the probability of an event occurring in a two or three-stage probability experiment is the same as the probability of the event occurring in a one-stage experiment. The impact of an experiment without replacement is Illustrated via egg roulette, where it is clear that eggs are ‘used up’ and no longer appear in the sample space in later stages. This misconception is addressed through detailed modelling of the sample space using a table approach for the first two stages.
* Students may assume that outcomes are equally likely. The distribution of cooked / raw eggs has been deliberately chosen to be heavily skewed towards cooked eggs. Students can be asked questions such as, ‘Are there more cooked or raw eggs?’ ‘Is it more likely [person] gets a cooked or raw egg? Explain why.’
* Students may be confused with the discrepancies between theoretical and experimental probabilities. An example such as tossing a coin once could be used where it is impossible to get half a head. Using the simulation to increase to a large number of trials allows for illustration of the Law of Large Numbers, reducing the discrepancy between the two.
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| Strategies | [Mathematics investigation](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/mathematics-investigation/)[Using games](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/using-games-and-storybooks/)[Concrete, Representational, Abstract (CRA)](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/concrete-representational-abstract-cra/)[Questioning](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/questioning/) |

Lesson structure

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| **Lesson hook**30 mins | **Warm-up question: Gambler’s fallacy**Show the warm-up question in slide 2 from the downloadable teacher’s slides. Connect to the [Egg Roulette video](http://www.mathematicshub.edu.au/search/egg-roulette/) ready to show the class or display the the online version of this lesson where the video is embedded in the Learning hook.Lavina tosses a coin 4 times and gets Head, Head, Head, Head. What do you think the next toss will be? Explain your answer.Expected responses include: * ‘Heads – because the coin is biased’. This is a possibility, but there is a $\frac{1}{16}$ of getting 4 heads in a row with a fair coin, which is not that unlikely.
* ‘Tails – because it’s due’, which is an example of the Gambler’s Fallacy – the student believes (incorrectly) that a random event (tails) is more likely to happen based on the outcome of the previous series of events, but each toss is independent of the previous ones.
* I can’t say – it’s 50/50 between heads and tails – the most correct response.

**Learning hook**: Egg roulette – playing the gameThis lesson is based around the game of egg roulette, which is based on a game originally seen in *The Tonight Show with Jimmy Fallon*. A video link has been provided above of two teachers playing egg roulette, which can be used as the basis of the lesson. Alternatively, teachers can conduct their own egg roulette in their school (with fellow teachers or possibly with students) or may be able to source videos online from the original TV show with celebrities. The rules of egg roulette are explained in the video, but in essence there are 12 eggs, 3 raw and 9 cooked and the contestants take it in turns to choose an egg and smash it on their head. They are hoping to avoid the 3 raw eggs!Watch the video and stop at 1 min 19s. Ask the students:* ‘Can you recap/explain the game to me?’
* ‘Miriam has chosen to go first. What is the probability that she picks a raw egg? A cooked egg?’ Correct answers: Raw $\frac{3}{12}=\frac{1}{4}$ and cooked $\frac{9}{12}=\frac{3}{4}$ .
* ‘Why might she have chosen to go first? Is that a good idea?’ From a probability point of view, it makes no difference. She may have wanted to get it over with or didn’t want to end up potentially with the last egg and knowing that it had to be raw.

Watch the video and stop at 2 min 5s. Ask and discuss the students the following questions.* ‘The first two eggs were cooked. Have they been lucky? Do you think that was the most likely outcome?’ This will be answered in the next activity.
* ‘What do you think is the chance that the next egg (Miriam) is raw? Have her chances of getting a raw egg worsened or improved since the game started? Why?’ Now only 10 eggs remain and 3 are raw so Miriam now has a $\frac{3}{10}$ chance of getting a raw egg versus $\frac{3}{12}$ at the start, so she now has more chance of getting a raw egg.

Watch the video and stop at 3 min 19s. Ask the students:* ‘Miriam says Denise was right not to have a good feeling about that egg. Was Miriam right or was Denise just unlucky? What is the probability that Denise gets an egg that go?’ Before Denise chose, 9 eggs remained and 3 were raw so Denise had a $\frac{3}{9}=\frac{1}{3}$ chance of getting a raw egg. Although the chance of picking a raw egg has kept increasing as more and more cooked eggs are gone, she still has a higher chance of choosing a cooked egg than a raw one.
* ‘Now Denise has got a raw egg, how have things changed? What is the chance that Miriam gets a raw egg in her next go?’

Both the number of eggs AND the number of raw eggs has changed. Now 8 eggs remain and 2 are raw so Miriam now has a $\frac{2}{8}=0.25 $or $25\%$ chance of getting a raw egg, but the go before she had a $\frac{3}{10}=0.3 $or $30\%$ chance of choosing a raw egg. The odds of Miriam picking a cooked egg have improved now one of the raw eggs is gone.Watch the video and stop at 3 min 47s. Ask the students:* ‘Denise says it’s impossible to get two in a row. Miriam says it is possible. Why does Denise think this? Who is correct?’ Denise is falling for the Gambler’s Fallacy and she doesn’t want to pick a raw egg. With 7 eggs remain and 2 are raw, Denise has a $\frac{2}{7}≈29\% $chance of choosing a raw egg, so Miriam is correct, it really is quite possible.’

Watch the video and stop at 4min 19s. Ask the students:* ‘After she gets two eggs in a row, Denise says that this is not very fair. Is she correct?’ The game is completely fair – there are 12 possible times that a raw egg can be picked and there are 3 raw eggs. They are equally likely to end up in any of the 12 time slots. Denise just doesn’t feel it’s fair because she’s has had two in a row, but that is just bad luck.
* ‘Denise then says Miriam has to get one. Is this correct? What is the chance Miriam now gets a raw egg?’ There are 6 eggs remaining and only one raw egg, so Miriam has a $\frac{1}{6}≈17\%$ chance of choosing raw. This is the best chance she has had all game because there are so few raw eggs remaining. So, Denise is quite wrong – Miriam would be quite unlucky if she chooses a raw egg.

Finish watching the video. |
| **Explore /investigate**20 mins | [Explicit teaching](https://www.mathematicshub.edu.au/plan-teach-and-assess/teaching/teaching-strategies/explicit-teaching/)* Define a **compound event** in probability as an event that consists of more than one event occurring at the same time (for example, tossing a coin and drawing a card) or repeating an event twice or more (for example, tossing a coin twice).
* Outline the learning outcome and success criteria for the lesson, highlighting that egg roulette is an egg-cellent example of a probability experiment **without replacement** as once an egg has been chosen it is no longer available for the next pick – both the total number of eggs and number of that type reduces by 1.
* Explain that probability experiments can be **with replacement**, where the first item is returned to the rest and so could be picked the second time or **without replacement** where once an item has been picked it is no longer available to be chosen next time. Note how sometimes the words with or without replacement appear in the question, but if not, you need to carefully analyse the question scenario, thinking about whether the thing you picked the first time is available to be chosen the second.

Note: Download and distribute the Egg-cellent worksheet to students to complete the questions. Full details of solutions and expected responses are provided in the downloadable Teachers’ notes.**With or without replacement activity** In pairs students analyse nine probability experiments found in downloadable Egg-cellent worksheet to decide whether Conduct a group discussion analysing the results, using questioning such as, ‘Why do you think that is a without-replacement experiment?’ ‘What are the available choices on the second pick?’**Egg roulette part 1 – exploring the probabilities**Refer students to this next activity in the worksheet. Students continue to work in pairs to complete the questions on using a sample space to help visualise probabilities and think through the abstract construct of the scenario logically. Full details of solutions and expected responses are provided in the teachers’ notes.  |
| **Summary and reflection**10 mins | After students have finished, come together as a class and use the time to go through the questions and answers in the Egg-cellent worksheet to ensure a deep connection with the content has been made and to provide further opportunity to clear up misconceptions.Key points are as follows.* In experiments without replacement, probabilities change at each stage and both the denominator and sometimes numerators need to change (depending on the previous pick and which outcome you are looking at).
* Tables / arrays are a good way to help visualise two-step probability experiments (like the first two picks).
* The game is initially fair, but as it progresses probabilities change owing to the without replacement property.
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| **Assessment** | The following suggestions is suggested as part of on-going assessment for Part 1 of this lesson sequence. Collect students’ Egg-cellent worksheets to review before next lesson to individually assess how students are progressing and whether they understand the main concepts so far. Remember to redistribute the worksheets for students to complete at the beginning of the next lesson.Consider further scaffolding activities for particular students to practise either for homework or in class during Egg roulette: Part 2. |