# Toadal eclipse

Students use gene therapy in cane toads to investigate dependent events. Weighted tree diagrams for dependent events are created to discover the impact that changing the gender of cane toads is having on population.

## Visible learning

### Learning intentions

* To know how to create a tree diagram.
* To understand the difference between dependent and independent events.

### Success criteria

* I can use a tree diagram to represent multistage events.
* I can describe the difference between dependent and independent events.
* I can explain how dependent and independent events change a tree diagram.

### Syllabus outcomes

A student:

* develops understanding and fluency in mathematics through exploring and connecting mathematical concepts, choosing and applying mathematical techniques to solve problems, and communicating their thinking and reasoning coherently and clearly **MAO-WM-01**
* solves problems involving probabilities in multistage chance experiments and simulations **MA5-PRO-C-01**

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## Activity structure

Please use the associated PowerPoint *Toadal eclipse* to display images in this lesson.

### Launch

1. Use slides 3–5 of the Toadal eclipse PowerPoint for a slow-reveal graph activity. For each slide, students will discuss in a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](http://www.bit.ly/thinkpairsharestrategy)), what they notice and what they wonder ([bit.ly/noticewonderstrategy](http://www.bit.ly/noticewonderstrategy)) about the graph displayed.

This teaching strategy is known as Data Talks ([bit.ly/datatalklink](https://bit.ly/datatalklink)), which are short 5–10-minute classroom discussions to help students develop data literacy. This strategy is similar in structure to a number talk, but instead of numbers, students are shown a data visual and asked what interests them.

Firstly, present a graph with some hidden features and ask the students what they notice and wonder. Students can then share some of their thoughts. Reveal some hidden features and ask students again what they notice and wonder. This process could be repeated a few times.

1. Discuss with students that the graph shows the cane toad recordings across the world and is from the ToadScan website ([bit.ly/toadscan](https://bit.ly/toadscan)).

Students have previously explored errors in measurement in *Unit 3 Prisms and cylinders, Lesson 6 – Margin for errors*. This could be referred to and discussed in terms of the data being collected by ToadScan, where the data is based on human sightings which is likely to contain errors.

1. Explain to students that in Australia they are trying to reduce the population of, and even eradicate, cane toads.

Students may like to know some background knowledge about why cane toads were introduced and why Australia is trying to stop the spread of cane toads. More information can be found on the PestSmart website ([bit.ly/petsmartcanetoads](https://bit.ly/petsmartcanetoads)).

1. Display slide 6 of the Toadal eclipse PowerPoint or the original article [bit.ly/wshredding](https://bit.ly/wshredding) which both explain the gene-editing technology known as a ‘w-shredder’. The ‘w-shredder’ can make female cane toads produce only male offspring.

### Explore

1. By working in visibly random groups of 3 ([bit.ly/visiblegroups](http://www.bit.ly/visiblegroups)) on vertical non-permanent surfaces ([bit.ly/VNPSstrategy](http://www.bit.ly/VNPSstrategy)), ask students to visually represent the outcomes of a pair of cane toads mating, if they have 3 generations of toads. Assume the toads only have one offspring per generation.

Students have been introduced to tree diagrams in *Lesson 03 – random relay*.

1. Slide 8 of the Toadal eclipse PowerPoint can be used to display the tree diagram on the board or to revisit the structure of tree diagrams with students.
2. Explain to students that for the following problem we will assume the probability of having a male or female is equal.
3. With groups still at their vertical non-permanent surfaces, have them refer to their tree diagram of 3 generations (or the diagram displayed on slide 8) to calculate the following probabilities:
4. all females
5. no females
6. two females only
7. **At least** one female (Path content)

Question d. is Path content. Teachers could ask this question of only some groups, all groups, or omit the question.

1. Select a non-volunteer student to present to the class how they calculated the probability that all generations were male. They could draw over the diagram displayed from the PowerPoint or refer to their diagram on their vertical non-permanent surface. Repeat for each of the probabilities.
2. Reintroduce the notion of dependent and independent events.

Students were introduced to dependent and independent events in *Lesson 01 – prediction palette.*

1. Facilitate a class discussion around whether gender selection is independent or dependent.
2. Reintroduce gene technology and ask students whether this gender selection is independent or dependent.
3. Tell students that with each generation, the probability of having a female offspring reduces by one tenth.
4. In groups, allow students time to construct a tree diagram for 3 generations of cane toads. The tree diagram should show the effect that the ‘w-shredder’ technology would have on cane toad populations.
5. Ask students assessing and advancing questions to further student thinking. Question suggestions are included below.

Assessing questions draw out students’ thinking about a problem and what methods they have tried so far.

Advancing questions are intended to help move student’s thinking forward toward the lesson goals. We want to draw their attention to something they may not have noticed or considered yet.

|  |  |
| --- | --- |
|  Assessing questions  | Advancing questions  |
| What are the chances of each event occurring?  | Can you write ½ as a fraction with a denominator of 10?  |
| How do you know your probabilities are correct? Did the relay results happen as expected? | How much does each generation of females decrease by? |

### Summarise

1. Bring the class back to their seats and discuss the tree diagrams used by students to represent the probability of toads who have been exposed to the gene technology. Slide 10 of the Toadal eclipse PowerPoint has the weighted tree diagram representing this data.
2. Pose the question: Will cane toads be eradicated in Australia because of this gene technology? This is an open-ended question with no fixed answer so class discussion should be encouraged.
3. Use slides 11-14 of the Toadal eclipse PowerPoint for the explicit teaching of constructing and interpreting tree diagrams with dependent events.

The explicit teaching technique used in the PowerPoint is ‘Your turn’. The first slide is a worked example which should be displayed for the students before using the following steps.

1. Reveal the question to students and its solution.
2. Students read in silence.
3. Students individually explain to themselves what is happening in each step.
4. Students hold a thumbs up to the teacher when they have finished reading and have some sort of understanding.
5. Think-Pair-Share. Students explain the solution to their partner.
6. In pairs, students then answer the self-explanation questions.
7. Finally, randomly select students to share their answers with the whole class.
8. Issue each student a copy of Appendix A ‘Which event type is it?’ where students are presented with 5 different scenarios.
9. In a Think-Pair-Share ([bit.ly/thinkpairsharestrategy](https://bit.ly/thinkpairsharestrategy)), students are to determine if the events are dependent or independent.
10. Bring the class back together to check understanding and clarify misconceptions.
11. Have students construct notes to their future forgetful selves ([bit.ly/notesstrategy](https://bit.ly/notesstrategy)) concentrating on the difference between dependent and independent tree diagrams.

### Apply

1. Pose the following problem to students:

‘You are a person that does not pair their socks. In your sock drawer there are 6 blue socks, 2 red socks and 2 white socks. Without looking, you select one sock and put it to the side before selecting another at random. What is the probability that the 2 socks will be the same colour?’

This problem can be made more ‘real’ and engaging by bringing in a drawer of socks to model the situation.

1. Assign new random groups of 3.
2. Have groups work at vertical non-permanent surfaces to calculate the theoretical probability of drawing 2 socks that are the same colour.
3. Have groups design and run a simulation for the problem. This could be drawing counters from a pile, creating a spreadsheet, or simulation of their creation.
4. Groups should then compare the results of their simulation with the theoretical probability they calculated.

Depending on your students, you might like to reverse the order of steps 3 and 4, so that students design and run the simulation prior to calculating the theoretical probability. Alternatively, students could be working on both the simulation and theoretical solution at the same time.

## Assessment and differentiation

### Suggested opportunities for differentiation

**Launch**

* A notice and wonder strategy is used where there is no correct answer, so that all students can participate in the discussion

**Explore**

* Students can draw tree diagrams without probabilities to limit their focus to the sample space for each event.
* Students may benefit from seeing the teacher draw the tree diagrams rather than present them using the PowerPoint.
* Groups can be challenged to consider what would happen if a second-generation or third-generation female cane toad received gene therapy. Groups could also consider what the tree diagram would look like if the gene therapy eradicated female offspring altogether.

**Apply**

* Don Steward’s ‘creating a fair game with counters’ (<https://bit.ly/creatingfairgame>)extends students into probability proofs using algebra.

### Suggested opportunities for assessment

**Launch**

* **Students’ responses to the data talk activity could be used to assess data analysis from an unknown data source.**

**Explore**

* Monitor students’ contribution to group work.
* When placed in groups of 3, students provide and receive peer feedback on their understanding.
* Students will demonstrate their working mathematically skills in discussions and justifications.

**Summarise**

* **Observe student’s attempts at the ‘Your turn’ questions.**

**Apply**

* Create an exit ticket where students need to add data to one of the scenarios in Appendix A ‘Which event type is it?’ and draw a 2-stage event tree diagram.
* When students move from theoretical probability to a simulation, if students’ results are significantly mismatched, they should question their work and evaluate their reasoning.

## Appendix A

### Which event type is it?

**Definitions**

A **dependent event** is an event that relies on another event to happen first. One event influences the probability of another event.

Two events are **independent** if knowing the outcome of one event tells us nothing about the outcome of the other event.

**Scenario 1**

Your mum has brought home a box of chocolates for your family to share. There is a mixture of dark and milk chocolates to choose from. Each family member takes a chocolate before you. Is choosing a chocolate an independent or dependent event? Explain your thinking.

**Scenario 2**

You are at a Chinese restaurant with 5 of your friends. You all choose a dish of your own to eat. Is choosing a meal an independent or dependent event? Explain your thinking.

**Scenario 3**

You are at a Chinese restaurant with 5 of your friends. They want to share the dishes, so every person has a choice of one dish each. Is choosing a meal an independent or dependent event? Explain your thinking.

**Scenario 4**

You are playing cards with a group of friends. Each person gets 5 cards. Is receiving a picture card an independent or dependent event? Explain your thinking.

**Scenario 5**

A roulette wheel consists of numbers on a wheel, some black, some red and one green. People bet on a small ball landing somewhere on the wheel. Is spinning a roulette wheel multiple times an independent or dependent event? Explain your thinking.

## Sample solutions

### Appendix A – Which event type is it?

Scenario 1 – dependent event as the chocolates are not replaced.

Scenario 2 – independent event as 2 people can choose the same dish.

Scenario 3 – dependent event as each dish when sharing is ideally different therefore if one person chooses a dish, this dish is no longer available for selection.

Scenario 4 – dependent event as each card is not replaced before dealing the next.

Scenario 5 – independent event as each time the wheel is spun the ball has the same chance of landing on any of the slots. The previous spin has no bearing on the next spin.

### Apply

The best approach is to look at it, result by result:

Option A: you get a pair of red socks.

There are 10 socks in the drawer and 2 are red. The probability that the first sock will be red is $\frac{2}{10} = \frac{1}{5}$. There is now only one red sock remaining in the draw, and a total of nine socks, so the probability of a second red sock is $\frac{1}{9}$. The probability that the pair will be red is the multiplication of the two: $\frac{1}{5}× \frac{1}{9} = \frac{1}{45}$.

Option B: you get a pair of white socks.

The great news is that this is also $\frac{1}{45}$. There’s just as many reds as whites so we can say the probability of a pair of white socks is the same as the probability of a pair red socks.

Option C: you get a pair of blue socks.

Of the initial 10 socks, 6 are blue. The probability that the first sock will be blue is $\frac{6}{10} = \frac{3}{5}$. There are now 5 blue socks left and 9 socks in total. The probability that the second sock will be blue is $\frac{5}{9}$. Therefore, the probability that both socks will be blue is the multiplication of the two: $\frac{3}{5} × \frac{5}{9} = \frac{15}{45} $

To choose 2 socks that are the same colour, we can choose a pair of red socks or a pair of white socks or a pair of blue socks. We need to add the different options together. That means, red plus white plus blue becomes: $\frac{1}{45} + \frac{1}{45} + \frac{15}{45} = \frac{17}{45}$.

## References

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