PRIMARY + STEM

Teaching Resource

ACTIVITY:

Chocolate Probability

ACTIVITY OVERVIEW

Probability is encountered in many aspects of our lives, from game-playing to weather forecasting, predictions for the future and gambling. In the Australian curriculum, the topic of chance increases in complexity through the year levels with a clear progression, allowing simple probability activities to be easily modified to suit all year levels. By changing the questions asked to students and the outputs required (e.g. graphs, answers), this activity can be used by any primary school year level. Even the youngest students, who do not formally have probability in their curriculum can use this activity for counting, using number names and making comparisons between students.

Although using food in the classroom can sometimes be more difficult, as you cater for allergies, food activities are always well-received by students and can be some of the most memorable maths lessons. Let's get probability off the paper and maybe next time students eat a chocolate treat they will stop and talk to their family and friends about maths!

SYNOPSIS

Probability is encountered in many aspects of our lives, from game-playing to weather forecasting, predictions for the future and gambling. In the Australian curriculum, the topic of chance increases in complexity through the year levels with a clear progression, allowing simple probability activities to be easily modified to suit all year levels. By changing the questions asked to students and the outputs required (e.g. graphs, answers), this activity can be used by any primary school year level. Even the youngest students, who do not formally have probability in their curriculum can use this activity for counting, using number names and making comparisons between students.

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Foundation – Year 2

- F: Connect number names, numerals and quantities, including zero, initially up to 10 and then beyond. (VCMNA070)
- F: Compare, order and make correspondences between collections, initially to 20, and explain reasoning. (VCMNA072)
- Y1: Identify outcomes of familiar events involving chance and describe them using everyday language such as 'will happen', 'won't happen' or 'might happen'. (VCMSP100)
- Y2: Identify practical activities and everyday events that involve chance. Describe outcomes as 'likely' or 'unlikely' and identify some events as 'certain' or 'impossible'. (VCMSP125)

Year 3 – 4

- Y3: Conduct chance experiments, identify and describe possible outcomes and recognise variation in results. (VCMSP147)
- Y4: Describe possible everyday events and order their chances of occurring. (VCMSP175)
- Y4: Identify everyday events where one cannot happen if the other happens. (VCMSP176)
- Y4: Identify events where the chance of one will not be affected by the occurrence of the other. (VCMSP177)

Year 5 - 6

- Y5: List outcomes of chance experiments involving equally likely outcomes and represent probabilities of those outcomes using fractions. (VCMSP203)
- Y5: Recognise that probabilities range from 0 to 1. (VCMSP204)
- Y6: Describe probabilities using fractions, decimals and percentages. (VCMSP232)
- Y6: Conduct chance experiments with both small and large numbers of trials using appropriate digital technologies. (VCMSP233)
- Y6: Compare observed frequencies across experiments with expected frequencies. (VCMSP234)

ACTIVITY, MATERIALS AND INSTRUCTIONS

Activity

Use mini-packs of chocolates to help students understand chance and probability in a tasty way. Please check food allergies before attempting this activity with your class.

Materials for class of 30 students

- Mini-packs of chocolates (e.g. M&Ms) x 30
- Paper cup (or reusable mug from school kitchen) x 30
- Grid paper, pencil, ruler, and coloured pencils (assuming that children all have these easily accessible in the classroom)

Instructions

1. Distribute mini-chocolate packs and cups, 1 each per child.

2. Tip your packet of chocolates into your cup. Don't eat yet!

3. *Foundation – Year one*: Count how many of each coloured chocolate are in your cup. Draw and colour circles on your page to show your results.
   Year two – Year six: Make a graph showing the different coloured chocolates in your cup. Choose from a picture graph, or column/bar graph, listing the colours at the bottom (on the x-axis) and numbers up the side (on the y-axis).

4. See below for prediction and probability questions appropriate to each year-level at this point. Questions can be asked to older students individually, to record answers in their books. Younger students may be asked as part of a class discussion.

5. Close your eyes and pick one chocolate. Record your result on your page (e.g. draw a coloured dot, write the name of the colour).

   Don't eat yet! Place the chocolate back in the cup. Shake the cup to remix the chocolates.

   Repeat until you have 10 results, recording each time. Don't eat yet!

6. Did your chocolate-picking results match up with your probability predictions?

7. *Foundation – Year three*: Eat the chocolates. Activity ends.
   Year four – Year six: Eat a few chocolates, so that you have 10 remaining in your cup.
   Answer your questions from 'step four' again.

   Will your results be the same as last time? If I picked a lot of blue last time, will I pick a lot again this time? No - if I keep returning the chocolates to the cup (and I'm not cheating), the chance of picking a certain colour will not be affected by my last pick.

   Repeat 'step five' (picking with eyes closed, returning to cup, recording data 10 times).

   Eat the chocolates!

8. Combine results of all individual experiments to give a class set of data (add together every student's result in their 10 or 20 picks). This could be done by having each table group total their results for each colour, then combining table-group results. Alternatively, create a spreadsheet with columns for each colour and student names on the left. Students add their results and results can be totalled and displayed on the board.

9. Are our class results closer to our predicted probabilities? As we do more trials or repetitions, we should get results closer to the expected probabilities.

HOW TO USE THIS ACTIVITY WITH YOUR STUDENTS

Foundation - Year 2

Questions to ask Foundation students at 'step four':

- What colour did you find more of?
- What colour did you find less of?
- Did anyone find the same amount of some colours?

Questions to ask year one students at 'step four':

- Are there any results that we are certain will happen?
- Are there any results that will not happen (are impossible)?
- What results might happen? What colours can we pick?

Questions to ask year two students at 'step four':

- What colour are you likely to pick from your cup?
- What colour are you unlikely to pick from your cup?
- What colour is impossible to pick from your cup?
- Are there any results that we are certain will happen?

Years 3/4

Questions to ask year three students at 'step four':

- What possible outcomes can you identify? What colours could you pick from your cup?
- Do you think that every student will pick the same colours?
- Will our results all be the same?

Instructions for year four students at 'step four':

- Put your colours in order of chance of occurring, from least likely to most likely.

Years 5/6

Instructions for year five students at 'step four':

- List all possible outcomes that you could pick from your cup.
- Represent the probability for each outcome using fractions (e.g. 4/15).
- What do we notice about probabilities? A probability is always a number between zero and one. In this case we will have fractions.
- Add up your probabilities. What does it equal?

Note – Year six students may also choose to represent data in a pie chart.

Instructions for year six students at 'step four':

- List the probability of picking each colour from your cup as a fraction, decimal and percentage.

DISCUSSION SECTION AND KEY THEMES

KEY THEMES

What is probability?

Probability is how likely something is to happen. When we talk about probability, we also use the word 'chance'. In mathematics, usually, we are dealing with facts, and things that we are certain are true every time (e.g. a square has four sides, 2 + 2 = 4, 3 x 7 = 21).

In real life, we are not always certain about things happening and we use probability to help us work out what is more likely. Analysing probability is part of the statistics area of mathematics. Probability has its own vocabulary, as can be seen in the topic words below.

When students begin learning about probability activities usually include tossing a coin (heads or tails?) and rolling dice.

When students reach years five and six, they start to use fractions, decimals, and percentages to represent the probability of an event happening. When we say 'event' in maths we don't mean like a school sports day or a bush dance, it just means something that happens. Events in maths can include tossing a coin, rolling dice, or picking out chocolates from a set.

We begin writing probabilities as fractions, with the numerator (top number) showing the number of possible ways that something could happen, and the denominator (bottom number) showing the total number of possibilities. For example, what is the chance of rolling an even number on dice?

If I roll a two, four or six, that would be an even number, so my numerator is three. What are the total number of possibilities when I roll dice? There are six (1,2,3,4,5,6), so my denominator is six and the probability of rolling an even number on dice is $^{3}/_{6}$ or $^{1}/_{2}$ (when simplified).

Although younger students are not giving numerical values to probability, they do need to recognise possible outcomes (the number used in the denominator).

Probability in games

Students will have played games that involve probability. If we take the simple board game of snakes and ladders, dice are rolled to work out how far you move, and there is also a chance that you will land on a snake (move backwards) or ladder (move forwards).

Any game that only includes rolling dice to move is purely a game of chance. There is no way to become better at playing this game, there is no strategy to help you win, as you can't even choose to move in different directions. This is why snakes and ladders is a great game to play with people of all ages, and probably one of the first board games that children play.

More complex games involve more complicated probabilities. For example, a game of Cluedo gives players the option of choosing the direction of movement, combined with making guesses about suspects and weapons. The chance that certain things will happen changes every time you choose a different room to visit or guess a particular suspect.

Card games also involve probability. By knowing the number of playing cards in a pack, we can calculate the probability of particular cards being drawn from the pack, or being in another player's hand.

Probability in weather

We can never be entirely sure about what the day's weather will bring us (especially in Melbourne!) but we do rely on forecasts (predictions) by the Bureau of Meteorology (BOM) to help us prepare for our weekly activities.

When I visit the BOM website, I can see the 'chance of any rain' for locations all over Australia. This is expressed as a percentage (e.g. 80 per cent).

Usually, students spend recess and lunch time outside at school, however, on days with a high chance of rainfall, schools have a 'wet day timetable' ready to go, and alterations may be made to outdoor sporting activities.

Probability in team sports

You may not realise, but everyone who plays team sports is using probability. For example, if two players on a basketball team are open and within shooting range, you are more likely to pass it to the player who you have seen shoot more goals. In your head, you know which players are more likely to successfully shoot and you use this information to help decide where your pass should go.

Soccer (football) teams put a lot of thought into probabilities when it comes down to a result determined by a penalty shootout.

In a penalty shootout, individual players from each team must kick a goal past the opposition's goalkeeper. Coaches will be able to advise the goalkeeper on the most likely direction a player will kick, and may also substitute the regular goalkeeper for one that is more likely to stop penalty goals from being scored (e.g. Australia v. Peru in June 2022).

Probability on tv (sports betting ads)

There is an increasing amount of sports betting advertising that children are exposed to on television.

For example, in 2021, there were an average of 948 gambling ads on Victorian free-to-air television each day, although there are restrictions on how many of these can be shown at certain times of day, and during G-rated shows.

The effects of gambling in sport are not part of the mathematics curriculum, so you may wish to discuss with your students at another time. There are resources available from a variety of organisations, such as the Victorian Responsible Gambling Foundation.

QUESTIONS AND ANSWERS

Can I improve at playing games if I understand probability?

I can improve my results in some games by having a better understanding of probability. For example, one chess player calculates the likely move of their opponent based on all possible moves on the board, then uses this to select their own next move. Some games are always going to be entirely chance-based, such as snakes and ladders, and you can never improve your performance. Other games require skill - not probability or luck - and you can only improve at these with lots of studying and practise, for example, sports and computer games that involve hand-eye-coordination and strategies.

What if I can't eat chocolates?

You can still study probability without eating! Share your chocolates with a friend and maybe your teacher will provide you with an appropriate substitute treat (e.g. Skittles, jelly beans).

Can animals calculate probabilities?

Yes! In 2020, New Zealand researchers published a study after working with the kea, a bird. They showed that the kea could put together different pieces of information to determine which hand of the researcher was most likely to hold a specific token (that meant that they would get a food reward). You can read more about their research here https://theconversation.com/polly-knows-probability-this-parrot-can-predict-the-chances-of-something-happening-132767.

If I have a really good understanding of probability, can I win lots of money at the casino?

No - if you understand probability, you will know that casinos are set up so that you are more likely to lose money.

Can we predict the future?

Yes and no. There are some things in the future that we are certain will happen. Things like people getting older, day and night happening, my dog pooing. But there are also many things that might happen including who will win the footy grand final, what your first job will be, when it will hail next. Our future is a combination of these.

What jobs use a lot of probability calculations?

There are many jobs that rely on probability calculations. These include mathematicians, economists, meteorologists, statisticians, scientists, engineers, analysts (people who analyse data), market research, budget, financial, operations research, management.

What is the probability that I will live to be 100 years old?

Australian National University (ANU) researched longevity in Australia in 2013. They showed that females born in 2013 have a 16 per cent probability of living until age 100, and males born in 2013 have a 10 per cent probability of living until age 100. You can use these statistics to work out how many of the students in your class are likely to live to 100 years. Take the total number of girls and multiply by 0.16 - this will be the number of girls from your class that are likely to still be living at age 100. Take the total number of boys and multiply by 0.1 - this will be the number of boys from your class that are likely to still be living at age 100. For someone born in 1980, the probability of living to 100 is about 10 per cent (females) and about 5 per cent (males).

What does it mean when the sports betting ads come on in the footy and there's an amount of money listed next to each team?

When someone bets on a sport, they give money to an organisation or person, with the agreement that they will get a certain amount of money back if their chosen team wins. If their team does not win, they will get no money back (and their money is used to pay the other people who are winners). When a betting advertisement shows two teams with amounts of money listed next to them, this is giving us an idea of the chance of each team winning. Sometimes this is based on the results of past games, and sometimes this is based on how much money other people have bet on each team for this match.

The team with the lower amount of money next to their name is more likely to win (because the betting company doesn't want to pay a lot of extra money to a team that they expect to win).

The team with the higher amount of money next to their name is likely to lose, but some people like to bet on their favourite team or hope that the less-likely team will surprise everyone and win. Betting on sports is a type of gambling (this is also what is found in casinos and pokie machines). In Australia, you must be 18 years old to gamble.

Why do the different colours of M&Ms all taste the same?

Chocolates like M&Ms and Smarties are not made to be different flavours, they are only made to be different colours. The food dyes used to create the different colours on their surface do not provide any flavours. However, treats like Skittles and jellybeans are made to have different flavours and you might be able to taste the difference between the different coloured ones.

Why not try eating them with your eyes closed next time, and have a partner confirm the colour for you? Maybe you can taste flavours like lemon, orange, strawberry, apple, and grape.

OUTSIDE OR SUPPLEMENTARY READING

Gambling advertising (Victorian Responsible Gambling Foundation)
https://responsiblegambling.vic.gov.au/resources/gambling-victoria/gambling-advertising/

Longevity in Australia, ANU presentation (2013)
https://cheba.unsw.edu.au/sites/cheba2/files/_local_upload/resources/presentations-talks/pdfs/living-to-100-prof-heather-booth-longevity-australia.pdf

Introduction to probability (Khan Academy)
https://www.khanacademy.org/math/statistics-probability/probability-library/basic-theoretical-probability/v/basic-probability

Basic probability (Math Antics)
https://www.youtube.com/watch?v=KzfWUEJjG18

Probability Song by Peter Weatherall (older students)
https://www.youtube.com/watch?v=au8hf0-A27s

Probability Song by Adam Up Maths (younger students)
https://www.youtube.com/watch?v=J3zUsanyclM

3D-animated Math Probability Spinner video (cowboy-themed)
https://www.youtube.com/watch?v=QpfMwA0z_1Y

TOPIC WORDS

- Probability
- Chance
- Statistics
- Event
- Possibility
- Certain
- Impossible
- Likely
- Unlikely
- Happen
- More
- Less
- Same

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