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Lucky lottery

February 2024

Activity introduction

Quick summary

Lotteries have been around for literally thousands of years. The earliest evidence we have is from China, around 200 BCE. It is even possible that those lotteries helped to finance the Great Wall of China. Even today, many governments organise their own lotteries and use the proceeds to fund projects.

Lotteries are often thought of as separate to gambling, although this is a misconception. While they do not involve sitting in a casino or watching a horse race, buying a lottery ticket is unequivocally a form of gambling.

In this lesson, students play a simple lottery game, and analyse their odds of winning and how this influences the decisions they made.

Learning intentions

Students will:

- determine the possible outcomes for multistage experiments
- conduct a simulation modelling an event
- critically evaluate the odds of winning the lottery.

Syllabus outcomes

- **MAO-WM-01** 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
- **MA5-PRO-C-01** solves problems involving probabilities in multistage chance experiments and simulations.

The identified Life Skills outcome that relates to this activity is **MALS-PRO-01** applies chance and probability to everyday events.

Capabilities and priorities

Numeracy
Information and communication technology (ICT) capability
Critical and creative thinking
Ethical understanding

Topic
Gambling probability

Unit of work
Mathematics Stage 5

Time required
55 minutes

Level of teacher scaffolding
High - students will require strong scaffolding through the explicit instruction on calculating probabilities, but will be able to perform the tasks independently.

Resources required

- Calculators – one per student
- Individual devices that can connect to the internet – one per student
- Powerball Simulation
- Random number generator
- Student workbooks

Keywords
Gambling, betting, sports, casino, money, wellbeing, gaming.

Teacher worksheet

Teacher preparation

Gambling can be a high-risk activity and is a priority concern for young people. Therefore, before conducting the lesson on gambling, it is recommended that teachers read the Facilitator pack. The pack provides teachers and parents with essential information about gambling harm amongst young people and clarifies the nature of gambling-related behaviours and how to approach sensitive topics.

Learning intentions

Students will:

- determine the differences between experimental and mathematical probability
- conduct a simulation modelling an event
- critically evaluate the odds of winning the lottery.

Success criteria

Students can:

- calculate the experimental probability of selecting a correct combination of numbers from a lottery draw
- calculate the mathematical probability of selecting a correct combination of numbers from a lottery draw, using the brute force or the multiplication of options method
- discuss the risk vs reward investment of buying lottery tickets compared to the payout amount for low divisions, and the likelihood of winning those divisions
- run a simulation of the Australian Powerball to demonstrate the low likelihood of winning a jackpot.

Teaching sequence

25 minutes - Part A: Playing the numbers

20 minutes - Part B: More!

10 minutes - Part C: Australian Powerball

5 minutes - Reflection

Part A: Playing the numbers

Work through this resource material in the following sequence:

Step 1

Begin by writing the numbers from one to five onto your whiteboard. Explain to the class that they will be playing a very simple lottery. Tell them to imagine that you have a barrel containing five marbles, numbered one to five. You are going to draw two marbles out of the barrel at random, and students will try to pick those numbers in advance.

Step 2

Ask your class to make a guess as to how likely you are to win a game. Are you a 50% chance of guessing the two numbers correctly? 75%?

Step 3

Ask every student to pick two numbers between one and five inclusive, and record them in their workbooks.

Step 4

Use this link to simulate the random choice of two numbers from one to five.

It will give you ten sets of number pairs.

Step 5

Read out the first randomly generated pair, and record them on the board, as well as the number of students who guessed these two numbers correctly.

Step 6

Now have each student pick another pair. Continue until ten rounds have been played.

For example:

Winning numbers	Number of winners
3, 5	2
1, 3	2
2, 4	3
4, 5	0
3, 4	2
1, 5	2
1, 3	1
2, 5	2
1, 2	3
3, 5	2
Total:	19

Step 7

Calculate the percentage of games your class 'won'.

$$\textit{Percentage of wins} = \frac{\textit{number of wins}}{10 \times \textit{number of students in class}} \times 100\%$$

For example, if you have 23 students and 19 wins across the course of ten games, your percentage chance of winning is:

$$\textit{Percentage of wins} = \frac{19}{10 \times 23} \times 100\% = 8.26\%$$

Explain to students that this percentage was obtained through experiment.

Step 8

We can see how accurate it was by also calculating the mathematical probability.

We need to know how many different ways there are to select two numbers out of five.

Ask your students to try and work this out by themselves, and then see what methods they used. Encourage students to work to some sort of pattern as a way of keeping track of the possible outcomes, rather than randomly trying to come up with all of the combinations.

Step 9

The two most likely methods will be:

1. Brute force
2. Multiplication of options

Brute force: You could simply list every possibility and count them.

1, 2			
1, 3	2, 3		
1, 4	2, 4	3, 4	
1, 5	2, 5	3, 5	4, 5

This gives us ten possible outcomes, which is the correct answer.

Multiplication of options: Some students may recognise that you have five options for your first number, and four options for your second (as you can't select the same number twice). Multiplying these together gives you 20 choices.

Ask your class if they can work out why this answer is too big?

It is because doing it this way treats options such as '1 2' and '2 1' as different. In this case, it doesn't matter what order we draw the numbers in, the outcome is still exactly the same. As multiplication of options gives you twice the number of options, you simply halve the result to get the correct answer: ten.

Step 10

As there are ten possible choices, the true probability of correctly selecting the combination of marbles is:

$$P(\textit{choosing 2 correct numbers}) = \frac{1}{10} = 0.1$$

This converts to 10%, which is very close to our experimental result of 8.26%.

Step 11

This step is an interesting exercise in psychology.

Write down all ten number pairs, and add up the number of times they were selected by your class.

You could ask students to come up to the board and put a tally mark next to the pair they selected for each round.

	Amount of times selected by students									
Outcomes	1	2	3	4	5	6	7	8	9	10
1, 2										
1, 3										
1, 4										
1, 5										
2, 3										
2, 4										
2, 5										
2, 6										
3, 4										
3, 5										
Total:										

Part A: Playing the numbers

If your students were genuinely picking at random there should be an even distribution.

So in a class of 23, each pair should have been selected

$$\frac{23\ \textit{students} \times 10\ \textit{games}}{10\ \textit{pairs}} = 23 \text{ times}$$

- Do your results show that?
- Were any pairs, such as ‘1, 2’ or ‘4, 5’ selected less/more often? Ask your class why that might be.
- Do certain pairs feel less likely, even though we know they aren’t?

Part B: More!

Step 1

Have your class consider a variation of this lottery where you have to select three numbers out of seven.

Step 2

Do they think the chances will be better or worse than the 10% chance you calculated for the first lottery?

As a class, discuss your reasoning.

Step 3

Have your students calculate the chance of winning this game. The brute force method will take longer, but has fewer complications.

Brute force

1, 2, 3				
1, 2, 4	1, 3, 4			
1, 2, 5	1, 3, 5	1, 4, 5		
1, 2, 6	1, 3, 6	1, 4, 6	1, 5, 6	
1, 2, 7	1, 3, 7	1, 4, 7	1, 5, 7	1, 6, 7

2, 3, 4			
2, 3, 5	2, 4, 5		
2, 3, 6	2, 4, 6	2, 5, 6	
2, 3, 7	2, 4, 7	2, 5, 7	2, 6, 7

3, 4, 5		
3, 4, 6	3, 5, 6	
3, 4, 7	3, 5, 7	3, 6, 7

4, 5, 6

4, 5, 7 4, 6, 7

5, 6, 7

This gives us 35 choices.

Multiplication of options: You have seven choices for your first pick, six for your second, and five for your third. Multiplying these gives us 7 × 6 × 5 = 210 choices. Unlike the previous lottery, we cannot simply divide by two. Here we have to consider that every trio of numbers has six arrangements:

1, 2, 3	1, 3, 2	2, 1, 3	2, 3, 1	3, 1, 2	3, 2, 1

Therefore, we have to divide 210 by 6 to get 35 choices.

In other words, the chance of winning is:

$$\frac{1}{35} \times 100\% = 2.86\%$$

Significantly worse than our first game.

Note: If you wish to play this lottery with your students, you can use this link to generate the random numbers: Select 3 out of 7.

Step 4

Given that choosing three out of seven is an improbable chance, ask your class for their thoughts on choosing two out of eight. Choosing fewer numbers should make it easier, but you also have a larger pool to choose from.

Step 5

Have your class calculate the chance of winning this lottery. They should come up with 28 choices, for a percentage chance of 3.57%.

Part C: Australian Powerball

Step 1

Explain to students that the Australian Powerball lottery has you choose seven numbers from 1 to 35, plus a bonus ‘Powerball’ from 1 to 20. Prizes are awarded for correctly guessing 2-7 numbers plus the Powerball, or 5-7 numbers without the Powerball.

The odds of winning the first division prize (all 7 numbers plus the Powerball) are 1 in 134,490,400. The odds of winning the ninth division prize (2 numbers plus the Powerball) are 1 in 66.

The higher the division, the higher the prize money.

Step 2

Before beginning the simulation, discuss the odds of the lottery.

- **Are combinations of numbers more or less likely than any other?**
  Students should have an understanding that any combination of numbers has the same 1 in 134,490,400 odds of occurring.
- **Even 1, 2, 3, 4, 5, 6, 7, and 8?**
  While it would certainly be memorable if this draw occurred, in this exact order, and you might think there was something fishy happening on account of the lottery, it’s just as likely for this combination to occur as it is for every single other combination.

Step 3

Direct your class to Powerball Simulation.

Step 4

Direct students down the page to where it displays the odds of guessing the lottery draw correctly, and the payout for these divisions.

The odds of guessing a combination of 5 numbers (out of 35) correctly is 1 in 1,173.

To give students a better sense of what their single lottery ticket is buying, ask them:

- **If you had to guess all combinations of five numbers (1,173) to guarantee a win (100%), how much would this cost you at $1.21 a ticket?**
  $1,419.33

- **What about to guarantee yourself a 50% chance at success?**
  (1,173 ÷ 2) x $1.21 = $709.67.

- **Buying one ticket only costs $1.21, but what is the percentage chance of picking five numbers with only one ticket?**
  1 ÷ 1,173 = 0.085%
- And for all of this, the payout would be… $70.87.

Step 5

On the simulation, instruct students to choose the standard game mode (where each entry costs $1.21), 100 draws per second, and $1K in their account. Then they select their numbers, plus the Powerball.

When they click ‘Start Simulation’ they will see exactly what happens to their account balance!

Step 6

After they’ve run a few simulations, ask students to refer to the table of ‘Winning Draws’. How many numbers, on average, did they select correctly? It might be somewhere in the range of 2, 3, or 4 numbers, plus the Powerball, and this makes sense: the chances of picking three numbers correctly plus the Powerball are 1 in 188.

However, remind students that this is all for a payout of only $17.54, and this table is only showing the draws that students ‘won’. How many other draws (at least 187, on average) were simulated that students’ numbers did not come up?

Reflection

Have your class write down a paragraph or two about whether or not this has changed their opinion on lotteries.

Prompt their thinking by asking:

- Do you think buying a ticket once a week is harmless fun, or is it a complete waste of money? It is just $1.21 after all, and you do have a chance of winning… although what is that chance, really?
- Does the excitement of checking the results each week perhaps make it worthwhile in a non-monetary way?
- How do you feel seeing someone win a big payout on the lottery? Statistically it has to happen sometime.
- But for every big winner, how many people are receiving no or a very small prize? How does this make you feel?

Teacher reflection

Take this opportunity to reflect on your own teaching:

What did you learn about your teaching today?

What worked well?

What didn't work so well?

What would you share?

Where to next?

How are you going to get there?