6

Poker machines

GambleAware

NSW GOVERNMENT

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Activity introduction

Quick summary

Australians spend nearly $25 billion each year on gambling, with the majority spent on the 200,000 poker machines across the country. New South Wales has almost 96,000 of these in clubs, hotels and casinos.

Machines in NSW must return a minimum of 85% of money invested by poker machine players as prize money payouts over their lifetime.

Machines are designed to keep players engaged while maintaining these return percentages.

In this lesson, students design a poker machine payout system which both guarantees a return of 85% of money invested, while also being fun and engaging for the player. Students then simulate these machines to test the 'actual' or real world payout of such machines, taking note of their feelings when playing. Ultimately, students realise that poker machines are very well designed to make a profit for the game operators.

Learning intentions

Students will:

- understand how poker machines are designed to keep players engaged
- understand how poker machines are designed to ensure a Return to Player of 85%
- understand poker machines are designed to guarantee a profit for their operators.

21st-century skills

Communicating

Community engagement

Creative thinking

Critical thinking

Entrepreneurship

Ethical behaviour

Problem solving

Syllabus outcomes

Mathematics Standard (Year 11)

- **MS11-6** makes predictions about everyday situations based on simple mathematical models
- **MS11-7** develops and carries out simple statistical processes to answer questions posed.

Mathematics Life Skills (Years 11 and 12)

- **MLS-S2** probability.

Stage 6 Mathematics Syllabus Statements

Students develop awareness of the applicability of algebra in their approach to everyday life. Students analyse different financial situations, to calculate the best options for given circumstances, and solve financial problems. They develop the ability to make informed financial decisions, to be aware of the consequences of such decisions, and to manage personal financial resources effectively. Students develop an ability to justify various types of financial decisions which will affect their life now and into the future.

Knowledge of statistical analysis enables the careful interpretation of situations and raises awareness of contributing factors. Study of statistics is important in developing students' understanding of the contribution that statistical thinking makes to decision-making in society and in the professional and personal lives of individuals.

Students develop an understanding of the language and elements of chance and probability and apply this in real situations.

Topic
Probability

Unit of work
Mathematics Stage 6

Time required
60 minutes

Level of teacher scaffolding
Low – support students in independent learning. You may need to check their maths and probabilities on their system designs.

Resources required

- Dice – 10 sided – two per student
- Random number generator
- Scientific calculator (optional) – one per student

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 and parents 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.

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- understand poker machines are designed to guarantee a profit for their operators.

Success criteria

Students can:

- calculate the payout scheme for poker machines.

Teaching sequence

5 minutes - Part A: Introduction to poker machines

25 minutes - Part B: Design and simulate a poker machine

25 minutes - Part C: A more complex machine

5 minutes - Part D: Reflection

Part A: Introduction to poker machines

Work through this resource material in the following sequence:

Step 1

As a class, discuss what students already know about poker machines.

Prompt their thinking by asking:

1. What are they?

2. How do they work?

3. Where have you seen them?

4. Are there different types?

Step 2

Explain that the theme of the poker machine games are different but the general principles are the same.

The machine has a number of vertical wheels which spin independently of each other when the player presses the play button. Players invest a small sum of money to make wheels spin. Depending upon the final position of the wheels a prize may be won.

These modern machines are a generation on from machines with a slot on the side to put coins in and an arm on the side which was pulled to spin the wheels. These machines were often referred to as slot machines or one-armed bandits.

Poker machines were first legalised in NSW in 1956. Other states such as Victoria and Queensland followed suit in the early 1990's.

Poker machines in NSW are required by law to have a Return to Player percentage of 85% over the machine's lifetime.

Step 3

Discuss:

- **What is the benefit to a state in having poker machines?**
  States derive a lot of income from gambling operators.
- **Why do you think the other states took so long?**
  Other states resisted because they saw people who have an issue with gambling losing money they could not afford to lose.
- **Why do you think clubs and pubs mostly have poker machines in rooms without windows?**
  This is to keep people gambling by losing track of time. This increases the chances of players reinvesting their winnings. There are often no clocks in the rooms, but there are clocks on each of the poker machines.

Part B:
Design and simulate a poker machine

Step 1

Ask students to imagine themselves as the designer of a new type of poker machine.

Step 2

Explain to students the rules of the simulation:

- There are only two wheels on this poker machine.
- Each wheel has 10 digits, 0–9.
- The two wheels are spun at the same time to form a two digit number.
- The numbers from 00 to 99 are the possible outcomes for two wheels when spun.
- We are going to charge $1 for each spin and assume that in the long run each number (00-99) will appear once every 100 spins.
- For 100 spins the income is $100 so to return 85% we need to have prizes totalling $85. This ensures that the poker machine meets the government mandated Return to Player percentage of at least 85%. Advise students that this simulation does not necessarily reflect results in real life because the Return to Player is based on the lifetime of the machine rather than per 100 spins.

Ask students to think critically and creatively about a payout system which encourages the player to keep playing. They will have to balance payouts to incentivise the player.

Using the rules above, we can say that, on average, $100 will be invested for 100 spins with each number appearing once, and therefore that combination of numbers needs to have a reward system that pays back $85.

Step 3

Before students design their own system, briefly discuss the benefits and drawbacks of the following proposed systems. You might wish to create a T-Chart to compare each system.

- **System A: A payout of $1 for the numbers from 00 to 84, no prize for 85 to 99.**
  In this system, you are essentially paying $100 to get a return of $85. The positive here is that the player wins lots of small prizes. However, if you win you get your money back and never actually have more than you bet, players would quickly get bored with this and think it was a rip off.

- **System B: A payout of $85 on the number 99.**
  In this system you would only win once every 100 spins. There is the promise of a big $85 payout, but it happens so rarely people may give up and stop playing this machine. There needs to be a combination of lots of small prizes and the lure of big payouts to keep people's interest.

- **System C: $5 for every double other than 99, and $40 for 99.**
  First of all, does this system meet the Return to Player? Ask students to calculate this. There are 9 doubles other than the 99. Therefore (9 x 5) + 45 = 85. This system has the promise of a big $40 payout, but also in the long run players will win $5 one in ten spins, which will keep them playing.

Step 4

Independently, students design their own system. Encourage students to balance small and large payouts to keep the player interested in their machine, while also ensuring their system pays out $85 per 100 spins.

Step 5

Have students swap 'machines' and run a simulation of this system.

They could do this by rolling two 10 sided dice, or by using a random number generator. Random numbers can also be generated on any scientific calculator which presumably your students will have. There is usually a button with RND or something similar which can be used. There must be a rule in place that the first two digits that appear is the number spun.

Give students 5 minutes to run as many trials as possible. Students record their results on a table. Whilst it may not be possible to run 100 trials (and the results of these trials would not accurately represent the probability in any case), students can still report on whether they found the system engaging, that is, whether they felt they were being rewarded enough to continue playing.

Step 6

Students report their findings as a class and offer constructive feedback on each others' systems.

Students reflect on:

- Did your simulation represent the real thing?
- How much fun was it?
- What percentage of the money was returned after your trial?

It is expected that there will be a wide variety of percentages achieved through these trials. The 85% return refers to the long run so we would need many more trials than this to be sure. If students have a very low or very high return then you should check to see if the mathematics of their payout system is sound, that is, is the payout really 85% in the long run.

Step 7

If you average all the individual %'s of every (correct) system, you should get a figure closer to 85%, since this would meet the threshold of the law of large numbers.

Step 8

Discuss:

- **In the real world players mostly go home with less than 85% of the money they started with. Why is this?**

For your first \$100 in the long run you get \$85 back.

Reinvesting that \$85 gives you \$72.25

Reinvesting that \$72.25 gives you \$61.41

Reinvesting that \$61.41 gives you \$52.20 and so on. It is like compound interest in reverse.

Also, the 85% return to player is guaranteed over the course of the machine's life. A player may insert \$100 and only receive \$40 back.

Extension

> **Note:** the following calculations are beyond the Mathematics Standard course and should only be used where appropriate.

Governments regulate the industry and continually monitor that each machine is working within the guidelines set. To do this they use statistics and binomial probability.

Binomial probability can be used whenever there are only two possibilities: success or failure.

In the case let p = probability of winning = 0.85

The probability of losing therefore is $1-p = 1 - 0.85 = 0.15$

For n trials, the probability of x successes is found using ${}^{n}C_{x} \times p^{x} \times (1-p)^{n-x}$

You may remember ${}^{n}C_{x}$ from previous lessons and it means the number of ways x objects can be chosen from n objects. All scientific calculators can directly calculate the value of ${}^{n}C_{x}$.

e.g. Find the probability of having 10 wins from 16 spins.

${}^{16}C_{10} \times 0.85^{10} \times (1-0.85)^{16-10} = 0.018$

Finding these individual probabilities is rather pointless and we would be much more interested in finding the chances of more than 10 wins.

For large numbers of n, the binomial distribution can be approximated by the normal distribution. (Note. A large number statistically is any number >71. Don't ask why, the answer only raises more questions.)

The regulators therefore ask questions such as: this machine has only returned 80% of money as prizes over its last 100 spins. Is something wrong with the machine?

To answer this we need to set confidence limits. For a normal distribution we know that 95% of the data lies within 2 standard deviations of the mean. If a machine was operating outside these limits we would be 95% sure that the machine is malfunctioning.

Back to our example.

Part B: Design and simulate a poker machine

For a binomial distribution the mean, $\mu = np$ and the standard deviation, $\sigma_x = \sqrt{np(1-p)}$

Mean, $\mu = 100 \times 0.85 = 85$

Standard deviation, $\sigma_x = \sqrt{100 \times 0.85(1-0.85)} = 3.57$

The confidence limits are therefore

$$85 - 2 \times 3.57 \text{ up to } 85 + 2 \times 3.57$$

$$77.9 – 92.1$$

Given the original question had 80% returned as prize money over 100 spins this is within the limits and the machine is allowed to keep operating.

If the machine keeps running at 80% after 1000 spins, redoing the calculations shows the limits become 827.3 – 872.6 and the 800 we have is outside the limits and the machine is shut down for investigation and/or repairs. The statistics tell us that there is a 95% chance there is something wrong with the machine.

Part C:
A more complex machine

Step 1

Now that students have the idea of how this all works let's increase the sophistication.

Explain to students the rules of the simulation:

- There are 3 wheels on this poker machine.
- Each wheel has 10 digits, 0 to 9.
- The three wheels are spun at the same time to form a three digit number.
- The numbers from 000 to 999 are the possible outcomes for each spin. This is now 1,000 different possibilities.
- We are going to charge $1 for each spin and assume that in the long run each number will appear once every 1,000 spins.
- For 100 spins the income is $1,000 so to return 85% we need to have prizes totalling $850. This ensures that the poker machine meets the government mandated Return to Player percentage.

Step 2

Independently, students design a system of payouts to return 85% of the money gambled as prize payouts.

Step 3

Students swap their systems and spend 10 minutes running simulations.

Step 4

Students report their findings as a class and offer constructive feedback on each other's systems.

Students reflect on:

- Did your simulation represent the real thing?
- How much fun was it?
- What % of the money was returned after your trial?

Part D: Reflection

Reinforce to students that people who start with $100 at the start of the night tend to walk away with less than $85 at the end of the night.

This is because for your first $100 in the long run you get $85 back.

Reinvesting that $85 gives you $72.25

Reinvesting that $72.25 gives you $61.41

Reinvesting that $61.41 gives you $52.20 and so on. It is like compound interest in reverse.

It is also important to note that Return to Player is not per player, but over the life of the machine, and per amount gambled, not money each player invests. This means that some players could not see that even that initial $85 return on a night of playing the poker machine, while another player might receive double the payout for the machine to make up for this.

This would be evident from students' simulations, where they were likely not able to exactly match the payout rates in their short play time.

Ask students to reflect on the process of creating a system which is designed to keep players playing. This is a real job for game designers and operators.

Students write a short paragraph on their thought processes when designing their own system, and how this makes them feel about real poker machines which are designed around the same principles of keeping players engaged.

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?