9

Multi-bets

GambleAware

NSW GOVERNMENT

Activity introduction

Quick summary

Multi-bets are bets that include more than one independent outcome. They are popular with gamblers due to the enticing larger prizes on offer compared to a single bet, and are used by gambling companies to increase the likelihood of people gambling by offering more options to bet on. However, with more options comes a decreased likelihood of getting every bet correct, and since a multi is reliant on every leg coming through to pay out, this means more risk for the gambler.

In this lesson, students will calculate both the payout and the odds for various multi-bets, demonstrating how even this increased payout does not match the probability of achieving such a bet, and therefore the risk and appeal of the bet should be weighed up.

Learning intentions

Students will:

- understand that what a multi-bet is

- understand that all legs of the bet must be successful to win a multi-bet.

21st-century skills

Critical thinking

Problem solving

Syllabus outcomes

Mathematics Standard (Year 11)

- **MS11-8** solves probability problems involving multistage events

- **MS11-5** models relevant financial situations using appropriate tools.

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
High – Students will require significant scaffolding to work through the possible combinations and to understand how the model is operating.

Resources required

- Appendix A: Student worksheet

- Whiteboard

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

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.

Learning intentions

Students will:

- understand that what a multi-bet is

- understand that all legs of the bet must be successful to win a multi-bet.

Success criteria

Students can:

- calculate the payout for a multi-bet

- understand that the probabilities must be multiplied for multi-bets.

Teaching sequence

15 minutes - Part A: Revisiting some probability concepts

15 minutes - Part B: Multi-bets

15 minutes - Part C: Taking multiple options in each leg

10 minutes - Part D: Reflection

Part A: Revisiting some probability concepts

Work through this resource material in the following sequence:

Step 1

Explain to students that an **independent** event is one where the probability of the event occurring is not influenced by another event.

Ask students to give examples of 2 independent events.

For example, the probabilities of tossing a head on a coin and rolling a 6 on a dice are independent of each other, because the result of one does not affect the other.

Step 2

Now ask students to give some examples of 2 events that are not independent of one another.

For example, the probability of the total of 2 dice being less than 6 and the probability of rolling a 6 on 1 of the dice is **not independent** as the result of one directly impacts the probability of the other.

Step 3

Explain to students that to find the probability of 2 or more independent events occurring we multiply the probabilities.

For example, to find the probability of drawing 2 king's from a deck of playing cards:

$$\text{Pr(first being a King)} = \frac{4}{52} \quad \text{(There are 4 kings in a deck of 52 playing cards.)}$$

$$\text{Pr(second being a King)} = \frac{3}{51} \quad \text{(There are 3 kings left in a deck of 51 playing cards.)}$$

$$\text{Pr(both being Kings)} = \frac{4^{1}}{52^{13}} \times \frac{3^{1}}{51^{17}} = \frac{1}{221}$$

Part A: Revisiting some probability concepts

Question 1

Independently, students find the probabilities of these multiple events (these questions can also be found on Appendix A: Student worksheet).

a. Tossing 2 heads in a row with a coin.

b. Tossing 3 tails in a row with a coin.

c. Rolling a 6 on the first throw of a dice and 4 on the second.

Answers:

a. $\dfrac{1}{2} \times \dfrac{1}{2} = \dfrac{1}{4}$

b. $\dfrac{1}{2} \times \dfrac{1}{2} \times \dfrac{1}{2} = \dfrac{1}{8}$

c. $\dfrac{1}{6} \times \dfrac{1}{6} = \dfrac{1}{36}$

Part B: Multi-bets

Step 1

Jake bets $5 on rolling an even number on a 6-sided dice. If he wins, he then bets his winnings on rolling a 3 on the next roll. What should his payout be if both legs of the bet win, based on the probability of these events occurring?

We can calculate by logic that

$$P(even) = \frac{1}{2}$$

so in a fair bet Jake should get a return of $10 for the $5 he initially bet.

Again, logic tells us that

$$P(3) = \frac{1}{6}$$

so a $10 bet will return $60.

Now that we know for 2 independent events both happening, we multiply the probabilities.

$$\frac{1}{2} \times \frac{1}{6} = \frac{1}{12}$$

A $5 bet will return 5 × 12 = $60.

Step 2

Explain to students that this is called a multi-bet as the bet includes more than one independent outcome.

For sports betting the initial odds are estimated by the operator based upon long term statistics for head-to-head clashes and an algorithm drawing on the players available, recent form, venue for the game and recent form. After the initial odds are set, they are altered as new bets are taken so that the operator will always win.

Step 3

Consider this list of odds for 3 matches of rugby.

Seahorses v Ferrets	
2.25	1.65
Spiders v Monkeys	
3.20	1.34
Mermaids v Seagulls	
11.00	1.03

Question 2

Independently, students calculate the payouts for multi-bets placed on the following outcomes (these questions can also be found on Appendix A: Student worksheet):

a. $5 multi-bet on the 3 favourites to win.

b. $2 bet on Ferrets and Spiders both winning.

c. $1 bet on Mermaids and Spiders both winning.

d. $5 bet on Ferrets and Seagulls both winning.

e. $10 bet on Seahorses and Spiders both winning.

Answers:

a. $1.65 \times 1.34 \times 1.03 = 2.27733$ for $1. For $5 the payout is $11.39

b. $1.65 \times 3.20 = 5.28$ for $1. For $2 the payout is $10.56

c. $11.00 \times 3.20 = \$35.20$ for $1

d. $1.65 \times 1.03 = 1.70$ for $1. For $5 the payout is $8.50

e. $2.25 \times 3.20 = 7.20$ for $1. For $10 the payout is $72.00

Step 4

This example highlights that multi-bets using only favourites slightly increases the payout but also increases the risk. To make multi-bets more attractive, punters will usually have more than 2 legs in their bet, and often one leg will have much longer odds.

Step 5

Here is a list of odds that were available for an AFL finals game.

Bulls v Meerkats	
1.38	3.07
Margin betting	
1-39 points 2.00	1-39 points 3.40
40+ points 3.75	40+ points 15.00

Betting on the first goal scorer of the match was also available.

Damian 8	Logan 10
Smith 9	Berger 12
Royce 12	Lloyd 14
Myers 18	Johns 14
Dangergrass 21	Track 15
Parfat 31	Kelly 26
Menzies 36	Hopping 41

Question 3

Independently, students calculate the payout for these multi-bets (these questions can also be found on Appendix A: Student worksheet):

a. Bull to win by 1-39 points and Royce to kick the first goal.

b. Meerkats to win and Kelly to kick the first goal.

Answers:

a. 2.00 × 12 = $24 for $1

b. 3.07 × 26 = $79.82 for $1

Step 6

Karl is very confident that The Magician's Donkey will win the third race but unfortunately many others agree with him and this horse is only returning $1.20 for the win. Gambling $1 to win only 20 cents doesn't sound very attractive so Karl looks at the next race and feels that either Sofarsogood (paying $2.20) or Shiny Fred (paying $3) will win.

To increase his payout, he bets $10 on The Magician's Donkey and then will invest half his winnings on each of Sofarsogood and Shiny Fred.

Question 4

Independently, students answer the following questions (these questions can also be found on Appendix A: Student Worksheet):

a. How many possible outcomes for Karl's betting in the 2 races?

b. What is the payout for a The Magician's Donkey win followed by a Sofarsogood win?

c. What is the payout for a The Magician's Donkey win followed by a Shiny Fred win?

d. What is Karl's profit if The Magician's Donkey wins and one of his selected horses wins?

Answers:

a. In Race 3 there are 2 outcomes The Magician's Donkey could win or lose.

   If The Magician's Donkey wins then there are 3 outcomes in Race 4. Sofarsogood could win, Shiny Fred could win or neither wins.

   2 possibilities into 3 possibilities gives 6 possibilities altogether.

b. $1.20 \times 10 = \$12$

   Half of this is bet on Sofarsogood, $6. $2.20 \times 6 = \$13.20$

c. $1.20 \times 10 = \$12$

   Half of this is bet on Shiny Fred, $6. $3 \times 6 = \$18$

d. $13.20 is a $3.20 profit and the $18 is an $8 profit on his initial bet of $10. Both are a marginal increase on the $2 profit he had from The Magician's Donkey winning the first race.

Part C: Taking multiple options in each leg

Step 1

One popular bet involves picking the winners in 4 races.

Here are the horse numbers and the odds for 4 races.

Race 1	Race 2	Race 3	Race 4
1 12.40	1 2.90	1 9.50	1 6.00
2 3.80	2 1.80	2 2.40	2 3.80
3 5.00	3 5.00	3 6.00	3 8.00
4 8.50	4 8.50	4 5.50	4 2.30
5 21.00	5 21.00	5 21.00	5 41.00
6 1.40	6 12.50	6 3.80	6 65.00
7 15.00	7 15.00	7 25.00	7 15.00
8 46.00	8 66.00	8 50.00	8 9.00

Question 5
(These questions can also be found on Appendix A: Student worksheet):

a. How many different combinations of 4 winning horses are possible?

b. What is the payout for betting on horses 1, 1, 1, and 1?

c. What is the payout for betting on horses 8, 8, 8, and 8?

d. What is the payout for betting on horses 2, 4, 6, and 8?

e. If you could place your own bet, which combination of horses has the maximum possible return?

Answers:

a. 8 × 8 × 8 × 8 = 4096

b. 12.40 × 2.90 × 29.50 × 6.00 = $6364.92 for $1

c. 46 × 66 × 50 × 9 = $1,366,200 for $1

d. 3.80 × 8.50 × 3.80 × 9.00 = $1104.66 for $1

e. The combination is 8885 and the payout is 46 × 66 × 50 × 65 = $9,867,000 for $1. This is a large return for a $1 investment but remember the odds of it winning are 9,867,000 to 1. You have a better chance of winning a lotto game. (8.3 million to 1).

Step 2

Pete the Punter wants to put a multi-bet on the winner of all 4 races above. Problem is, he isn't sure which horse is going to win each race, although he has narrowed it down somewhat.

He thinks that:

- the winner of Race 1 will be either horse 2, 3 or 6
- in race 2 he likes 1, 2 and 7
- in Race 3 he thinks it is between 2 and 6
- and in Race 4 he only likes the favourite, number 4.

Discuss the pros and cons of Pete's plan to cover multiple options on a single race.

If Pete wants to cover all possible options, there are 3 × 3 × 2 × 1 = 18 of them. If the result was random and every horse had the same chance of winning he has covered only 18 of 4096 possibilities. This is less than 0.5% of all possibilities, although it could be argued that it is better than only putting on 4 bets, one on each race.

Pete's risk is higher as he has to put more bets, and there's still a chance that none of the horse he picks will come in. Remember, if just one leg of Pete's multi-bet fails, he loses everything. However, the maximum potential payout is a winning combination of horses 3($5), 7($15), 6($3.80) and 4($2.30), in which case the payout would be 5 × 15 × 3.8 × 2.30 = $655.50.

Step 3

Let's return to our list of odds in the AFL final.

Bulls v Meerkats	
1.38	3.07
Margin betting	
1-39 points 2.00	1-39 points 3.40
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Part C: Taking multiple options in each leg

Damian 8	Logan 10
Smith 9	Berger 12
Royce 12	Lloyd 14
Myers 18	Johns 14
Dangergrass 21	Track 15
Parfat 31	Kelly 26
Menzies 36	Hopping 41

Question 6

Alyssa is a big Meerkats and wants to cover them to win by 1-39 points **as well as** 40+ points.
She also wants to include Logan, Berger and Hopping as the potential first goal scorer (these questions can also be found on Appendix A: Student worksheet):

a. How many options is she covering with these bets?

b. What is the minimum payout for a win for her?

c. What is the maximum payout for a win for her?

Answers:

a. 2 × 3 = 6 options

b. 3.40 × 10 = $34

c. 15 × 41 = $615

Step 4

Remind students that these payouts are attractive, but it must be remembered that the likelihood of winning is also very small. In this case there are 4 × 44 = 176 different possible outcomes, and Alyssa has covered only 6 of them.

Part D: Reflection

Discuss:

- **Why are multi-bets popular with gamblers?**
  The larger prizes that are available.

- **How does offering multi-bets increase the income for gambling operators?**
  By providing more options for the punter the likelihood of them gambling increases. The possibility of larger prizes is also attractive to many punters.

- **Throughout the 8 lessons we have seen the mathematics behind many different types of gambling. There are many others of course, but something they all have in common is that the operator is assured of winning. Explain some of the ways gambling organisations can be sure they will always win.**
  They take a percentage out of the pool before calculating the prizes. They offer odds that are less than those calculated by probability. They change the odds as bets are made so that it doesn't matter what the outcome, they still win.

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?

Appendix A: Student worksheet

Question 1

Find the probabilities of these multiple events:

a. Tossing 2 heads in a row with a coin.

b. Tossing 3 tails in a row with a coin.

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Question 2

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Appendix A: Student worksheet

Question 5

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4 8.50	4 8.50	4 5.50	4 2.30
5 21.00	5 21.00	5 21.00	5 41.00
6 1.40	6 12.50	6 3.80	6 65.00
7 15.00	7 15.00	7 25.00	7 15.00
8 46.00	8 66.00	8 50.00	8 9.00

a. How many different combinations of 4 winning horses are possible?

b. What is the payout for betting on horses 1, 1, 1, and 1?

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d. What is the payout for betting on horses 2, 4, 6, and 8?

e. If you could place your own bet, which combination of horses has the maximum possible return?

Question 6

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She also wants to include Logan, Berger and Hopping as the potential first goalscorer.

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