re(Solve) MATHS BY INQUIRY

Rock Paper Scissors

Y6

Summary of learning goals

- This sequence builds students' understanding of randomness. A random outcome is one for which all possibilities have an equal chance of being selected. Students recognise that games such as rock paper scissors are not truly random, as people's decisions are influenced by whether they win or lose the previous game. Students see that playing the same game with cards or using a computer simulation produces a random result.

Australian Curriculum: Mathematics (Year 6)

ACMSP144: Describe probabilities using fractions, decimals and percentages.

ACMSP145: Conduct chance experiments with both small and large numbers of trials using appropriate digital technologies.

ACMSP146: Compare observed frequencies across experiments with expected frequencies.

Summary of lessons

Who is this sequence for?

This sequence is for students who are:

- familiar with calculating the probabilities of different events
- ready to apply their understanding of fractions to express the probability of events occurring.

Lesson 1: How Random is it?

Students determine their chances of winning the game rock paper scissors (RPS), then test their chances by playing against another player and in a simulation card or dice game. Students look at the psychological aspect of the game and recognise that there is a strategy to increasing their chance of winning.

Lesson 2: Which is Better?

Students calculate the probabilities of winning the game rock paper scissors lizard Spock (RPSLS) and compare it to the chances of winning RPS. They decide which is the better game to play in different circumstances.

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Reflection on this sequence

Rationale

Randomness is a central idea in statistics and probability.

> *Randomness in statistics must be separated from the colloquial use of the word. In statistics, a random process – such as drawing names from a hat – requires that all possibilities have an equal chance of being selected.*

(AAMT, Top Drawer Teachers)

A random sample requires that each possible sample of the same size from the population has the same chance of being selected. This creates a fair, unbiased sample and is essential if we are looking for a meaningful explanation for our data. This sequence explores randomness in the games RPS and RPSLS. In these games, a player's choice of moves is generally influenced by whether they won or lost the previous round; so while the results may appear random, they are not. Students see that a game with dice, cards or against the computer produces more random results.

reSolve mathematics is purposeful

- This sequence builds students' understanding of randomness, which is a central idea in statistics and probability, through a well-known game.

reSolve tasks are inclusive and challenging

- It is anticipated that all students would be familiar with the game RPS, thus providing a common experience from which to draw upon.
- Students are challenged through an analysis of how a win or loss influences a player's choice of moves.

reSolve classrooms have a knowledge-building culture

- Students collate data from across the class to explore the probability of outcomes and to look for any regularities and patterns that might exist.

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LESSON 1

re(Solve) MATHS BY INQUIRY

Rock Paper Scissors

How Random is it?

Y6

About this lesson

Students determine their chances of winning the game rock paper scissors (RPS), then test their chances by playing against another player and in a simulation card or dice game. Students look at the psychological aspect of the game and recognise that there is a strategy to increasing their chance of winning.

Australian Curriculum: Mathematics (Year 6)

ACMSP144: Describe probabilities using fractions, decimals and percentages.

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ACMSP146: Compare observed frequencies across experiments with expected frequencies.

Mathematical purpose

- Students calculate their chance of winning in a game. They look at whether knowing how people are likely to behave can change the odds of winning.

Learning intention

- To investigate the chances of winning in the game RPS.

Time

Two lessons of approximately 1 hour each.

Vocabulary

- chance
- randomness
- simulation

Resources

- reSolve PowerPoint *1a Rock Paper Scissors*
- reSolve PDF *1b Rock Paper Scissors Cards*, printed and cut into cards (optional, see Test 1 below)
- reSolve PowerPoint *1c Rock Paper Scissors Simulation* (optional, see Test 1 below)
- dice (optional, see Test 1 below)
- reSolve PDF *1d The Secret to Winning*, printed and cut in half
- Student Sheet 1 – Score Sheet
- Student Sheet 2 – Results

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Teacher background information

This lesson explores the idea of randomness. In statistics and probability, a random process requires that all possibilities have an equal chance of being selected. The results display no recognisable pattern or regularities. For example, when a fair coin is tossed, it is equally likely that the result will be heads or tails. This is equally true for every subsequent toss. This means that when a head is tossed, it does not become more likely that the next toss will be a tail. Indeed, if a coin is tossed five times and the result is five heads, there is still an equal probability of a head or tail on the next toss.

What are your chances?

Resources: Show slide 2 of reSolve PowerPoint *1a Rock Paper Scissors*.

Discuss the rules of the game. Invite students to play a few games with a partner, the winner being the first to win three games.

Pose the question: *What is your chance of winning a game of RPS?*

Ask students to show and justify their chances of winning the game. Have the students present the probabilities as a fraction and share their justifications.

Slides 4–17 of reSolve PowerPoint *1a Rock Paper Scissors* give two visual explanations that show why you have an even chance of winning, losing or drawing.

Teacher notes:

- It has been shown that when a person plays RPS, their choice of move is not truly random. A player's next move is influenced by whether they won or lost the previous game. Based on this, it is possible to apply a strategy to increase your chances of winning. This is explored later in the lesson.

Testing the results

Explain to the students that they will be using two simulations to test the probabilities they have calculated.

Divide the students into groups of three. One person is player 1, one is player 2 and the third is the recorder. In the two different test situations, the players will play 20 games of RPS.

Resources: For each game, the recorder uses Student Sheet 1 – Score Sheet to record both moves.

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Test 1: Rock paper scissors simulation

In this test, students play a version of RPS whereby moves are chosen at random. A game can be played with cards, dice or against the computer as follows.

- **Cards:**

  Resources: Create a deck of cards from reSolve PDF *1b Rock Paper Scissors Cards* (you will need at least 10 copies of each card).

  Shuffle the deck and divide the cards evenly between two players. Each player turns over their top card. The winner is the person whose card shows the winning move.

- **Dice:** rock = 1 and 2, paper = 3 and 4, scissors = 5 and 6. Students play in pairs. Each player rolls a dice. The winner is the player whose dice rolls the winning move.

- **Computer:**

  Resources: reSolve PowerPoint *1c Rock Paper Scissors Simulation* will display a random move with every click.

  Play as a class with different students challenging the computer.

Have the students play 20 games and record the results.

Resources: Provide students with Student Sheet 2 – Results.

Have them calculate and record:

- the number of times rock or paper or scissors appears in the game
- the number of times player 1 wins or player 2 wins or the game is drawn.

Discuss whether each result appears an equal number of times. Collate the data from across the class and graph the results. It is likely that there will be less variation in the larger class dataset.

Test 2: Rock paper scissors tournament

There are many RPS tournaments held around the world and many videos are available online.
To introduce a class tournament, you might wish to first watch a video of a competition.

Again, have the players play 20 games and record the results on Student Sheet 1 – Score Sheet. Students then calculate and record the results from their game. The class data could be collected again.

Compare the data collected from both test situations and discuss whether each result appears an equal number of times.

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Is it really random?

Resources: Provide player 1 with a card from reSolve PDF *1d The Secret to Winning*, ensuring no-one but them reads the card.

Play another round of RPS. Again, the recorder records the results. It is much more likely that player 1 will have a greater number of wins. Compare the results across the class.

Watch the clip from ABC's television program Catalyst 'How to win at rock-paper-scissors' (at http://abcspla.sh/m/2851539). A summary of the information presented in this clip is also provided in slides 18–21 of reSolve PowerPoint *1a Rock Paper Scissors*.

Have students review their results from Test 2. Ask:

- *If you won, did you tend to play the same move again in the following game?*
- *If you lost the game, did you tend to change your play on the next go?*

Investigate: If the game was a draw, what move did each player tend to make in the next game? Can you determine a winning strategy after a draw?

Reflection: What makes it random?

Discuss: *Are you more likely to win at the game RPS when using cards or dice or the computer or with another person?*

Is playing the game using cards or dice or the computer or with another person more likely to produce an even spread of results?

Teacher notes:

- The psychological aspect of the game takes away the randomness of the game. A person's choice of moves is influenced by whether they won or lost the previous game. Based on this, it is possible to increase your chances of winning.
- When using the cards or dice or the computer game, there is an equal chance of each result.

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Score Sheet

Name: _____

Player 1	Player 2	Result
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw

Player 1	Player 2	Result
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw

Player 1	Player 2	Result
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw
R P S	R P S	P1 P2 Draw

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Results

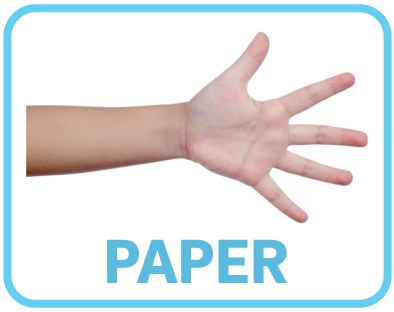
Name: _____

Simulation

Rock _____ Player 1 wins _____

Paper _____ Player 2 wins _____

Scissors _____ Draw _____



Game

Rock _____ Player 1 wins _____

Paper _____ Player 2 wins _____

Scissors _____ Draw _____

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LESSON 2

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Rock Paper Scissors

Which is Better?

Y6

About this lesson

Students calculate the probabilities of winning the game rock paper scissors lizard Spock (RPSLS) and compare it to the chances of winning rock paper scissors (RPS). They decide which is the better game to play in different circumstances.

Australian Curriculum: Mathematics (Year 6)

ACMSP144: Describe probabilities using fractions, decimals and percentages.

ACMSP145: Conduct chance experiments with both small and large numbers of trials using appropriate digital technologies.

ACMSP146: Compare observed frequencies across experiments with expected frequencies.

Mathematical purpose

- Students calculate the probability of winning the game RPSLS. They use their findings to decide which form of the game is fairest.

Learning intention

- To determine whether RPS or RPSLS is a fairer game.

Time

A lesson of approximately 1 hour.

Vocabulary

- fairness

Resources

- reSolve PowerPoint *2a Rock Paper Scissors Lizard Spock*
- reSolve PDF *2b Icons* (optional)
- Student Sheet 1 – RPSLS Score Sheet

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Introduction

Introduce the game RPSLS to students by watching the clip https://www.youtube.com/watch?v=iSHPVCBsnLw.

Briefly discuss Sheldon's claim that 'players familiar with each other will tie 75% to 80% of the time' in traditional RPS. Is this supported by students' findings in Lesson 1: How Random is it?

Resources: Discuss the rules, as shown on slide 2 of reSolve PowerPoint *2a Rock Paper Scissors Lizard Spock*.

Pose the question: *Do you think your chances of winning in this game are increased, decreased or the same compared to playing RPS?*

Ask students to show and justify their chances of winning the game. Students could be encouraged to use one of the visual representations used in Lesson 1.

Resources: The reSolve PDF *2b Icons* provides icons that the students might like to use.

Have students present all probabilities as a fraction.

Extending prompt:

- *RPS and RPSLS both have an odd number of possible moves. Why? Could the game be played with an even number of moves?*

Students will see that the chances of a draw decrease and the chances of a win or loss increase when compared with the traditional game. This can also be seen in the visual representation on slide 2 of reSolve PowerPoint *2a Rock Paper Scissors Lizard Spock*: there are five different moves that can be made and for each move there are two possible ways of winning (represented by the arrows pointing out) and two possible ways of losing (represented by the arrows pointing in).

Select some students to present their working to the class.

Slides 3–8 show all possible outcomes as a two-way table.

Testing the probabilities

Divide the students into groups of three. One person is player 1, one is player 2 and the third is the recorder. Have them play 20 games of RPSLS.

Resources: For each game, the recorder records all moves on the score sheet provided in Student Sheet 1 – RPSLS Score Sheet.

Have students calculate and record the results from their game. Ask: *How accurately do your results reflect your chances of winning?*

Collate the class data from the different games. Ask: *How accurately do the class results reflect your chances of winning?*

As it is a much larger dataset, it is probable that the data will better reflect the previously calculated probabilities.

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How random is it?

Show students slides 9 and 10, which summarise findings from Lesson 1, and review how a person's next move is influenced by whether they won or lost the previous game.

Have students review the data that they collected in Lesson 2.

Pose the questions: *Were players influenced in the same way as in Lesson 1?*
Can you work out a winning strategy?

Reflection: Which is better?

Consider the three different forms that have been played in the two lessons:

- RPS using cards or dice or the computer
- RPS with another person
- RPSLS with another person.

Discuss: RPS and RPSLS are often used to make decisions.

- *Which of the three forms of the game would be fairest to play? Why?*
- *Which game would you use to challenge another person? Why?*

T Teacher notes:

The last question is intentionally ambiguous in order to prompt a variety of responses. Possible student responses could include:

- 'RPS because I know a winning strategy.'
- 'RPSLS because we are less likely to draw.'
- 'RPSLS because it is fairer.'

Further activities

A game needs an odd number of moves to ensure that each move either wins or loses against all the other possible moves. Invent some new moves for the game so that:

- With three moves, the chance of winning is 3 in 9 or $\frac{1}{3}$.
- With five moves, the chance of winning is 10 in 25 or $\frac{2}{5}$.
- What would be the chance of winning with seven moves? Nine moves? 101 moves?
- Can you make a generalised statement to determine the chances of winning with any odd number of odd moves?

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RPSLS Score Sheet

Name: _____

Player 1					Player 2					Result		
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw
R	P	Sc	L	Sp	R	P	Sc	L	Sp	P1	P2	Draw

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