Lesson Plan: Probability – Yahtzee!

LEVEL / YEAR: 9/10	STRAND: Statistics and Probability	TOPIC: Independent and dependent events
In the Classroom		
PURPOSE / LEARNING INTENTIONS	To investigate conditional probability in the context of the game Yahtzee.	
KEY QUESTIONS	What do the words 'independent' and 'dependent' mean in relation to probability? What is the meaning of 'conditional' in relation to probability? Can you describe events in terms of 'and' and 'or'? How does this help you when calculating probabilities?	
WARM UP	Students should have had experience using probability trees and calculating probabilities using tress before this investigation. Discuss the rules of the game Yahtzee – maybe play a few rounds with the class. Discuss what strategies you could use to maximise your scores.	
EXPLICIT TEACHING & LEARNING	Introduce the problem (see PowerPoint) The initial problem is very complex, discuss with the students ways of simplifying the problem: • Fewer dice • Fewer throws Start the student with one die and three throws. (It will then be easier for them to increase the number of dice, building to 5.) This is an investigation and the students should be left to explore the problem on their own. Only give direction if the students are unable to move on themselves and are giving up. Encourage them to struggle with the problem. (The following explanation and PowerPoint uses a tree diagram to model the problem and for the calculations. Students may use other methods.) If you see that they are struggling, here are some ideas for putting them on the right track: • How will they model the experiment/events? • Suggest a tree diagram • Students may initially draw the tree diagram with 6 branches (one for each possible outcome) – you could suggest that there are in fact only two outcomes – 6 (the desired result) and everything else (the unwanted result). This makes the diagram much simpler – what are the probabilities on the branches now? • How will they model the second and third throws? • Do all branches have branches? Once students have modelled the experiment they will need to calculate the relevant probabilities, see the PowerPoint. At this point it may be useful to show how using the words 'and' and 'or' when "reading" the tree diagram is useful in deciding what calculations need to be performed (+ or x) When students are confident they understand the one die problem ask them to extend to two dice, three dice etc.	

REFLECTION	There are a lot of opportunities for discussion here on conditional probability. Other questions that can be asked include: • How could you change the rules to make it easier? • How could you calculate the probabilities of other desired outcomes in the game? • Does calculating these probabilities change the way you would play the game/help you with strategies? • What strategies wold you use when playing the game?
RESOURCES	PowerPoint Dice – if you want to let the students play the game first For other approaches to solving the problem see: • https://www.wikihow.com/Play-Yahtzee • https://www.thoughtco.com/probability-of-rolling-a-yahtzee-3126593 • http://datagenetics.com/blog/january42012/index.html • http://mathworld.wolfram.com/Yahtzee.html • http://www.yahtzee.org.uk/probability.html
Curriculum Connections	
AT LEVEL 9	List all outcomes for two-step chance experiments, both with and without replacement using tree diagrams or arrays. Assign probabilities to outcomes and determine probabilities for events (ACMSP225) Calculate relative frequencies from given or collected data to estimate probabilities of events involving 'and' or 'or' (ACMSP226)
PROFICIENCIES – YEAR 9	**Understanding** includes describing the relationship between graphs and equations, simplifying a range of algebraic expressions and explaining the use of relative frequencies to estimate probabilities and of the trigonometric ratios for right-angle triangles **Fluency** includes applying the index laws to expressions with integer indices, expressing numbers in scientific notation, listing outcomes for experiments, developing familiarity with calculations involving the Cartesian plane and calculating areas of shapes and surface areas of prisms **Problem-solving** includes formulating and modelling practical situations involving surface areas and volumes of right prisms, applying ratio and scale factors to similar figures, solving problems involving right-angle trigonometry and collecting data from secondary sources to investigate an issue **Reasoning** includes following mathematical arguments, evaluating media reports and using statistical knowledge to clarify situations, developing strategies in investigating similarity and sketching linear graphs.
AT LEVEL 10	Describe the results of two- and three-step chance experiments, both with and without replacements, assign probabilities to outcomes and determine probabilities of events. Investigate the concept of independence. (ACMSP246) Use the language of 'if ....then, 'given', 'of', 'knowing that' to investigate conditional statements and identify common mistakes in interpreting such language. (ACMSP247)

PROFICIENCIES – YEAR 10	**Understanding** includes applying the four operations to algebraic fractions, finding unknowns in formulas after substitution, making the connection between equations of relations and their graphs, comparing simple and compound interest in financial contexts and determining probabilities of two- and three-step experiments **Fluency** includes factorising and expanding algebraic expressions, using a range of strategies to solve equations and using calculations to investigate the shape of data sets **Problem-solving** includes calculating the surface area and volume of a diverse range of prisms to solve practical problems, finding unknown lengths and angles using applications of trigonometry, using algebraic and graphical techniques to find solutions to simultaneous equations and inequalities and investigating independence of events **Reasoning** includes formulating geometric proofs involving congruence and similarity, interpreting and evaluating media statements and interpreting and comparing data sets.
WHAT CAME BEFORE AT LEVEL 8	Identify complementary events and use the sum of probabilities to solve problems (ACMSP204) Describe events using language of 'at least', exclusive 'or' (A or B but not both), inclusive 'or' (A or B or both) and 'and'. (ACMSP205) Represent events in two-way tables and Venn diagrams and solve related problems (ACMSP292)
VOCABULARY	Probability Event Outcome Sample space Conditional Independent event Dependent event Tree diagram Combinations Permutations
ASSESSMENT/ SUCCES CRITERIA	Students should be comfortable in using the vocabulary to describe an event/experiment' Students should be able to calculate the probability of two events occurring independently or dependently.
DIFFERENTIATION AND EXTENSION	Students will need different levels of help with the initial problem. Some students will be able to move on from the initial problem, with one die, to solve the overall problem using 5 dice. This is an open-ended task and students should be encouraged to pose and solve their own questions. Students may want to try and write a computer program to play Yahtzee.