*1. Teaching & Learning Plan – Determining Probability of various outcomes when rolling 2 die*

**Authors:** P. Connolly, D. Fox & S.Gammell, Scoil Chonglais, Baltinglass, Co. Wicklow.

**Target Students:** First Years

**Duration of Lesson:** 35 – 70 minutes?

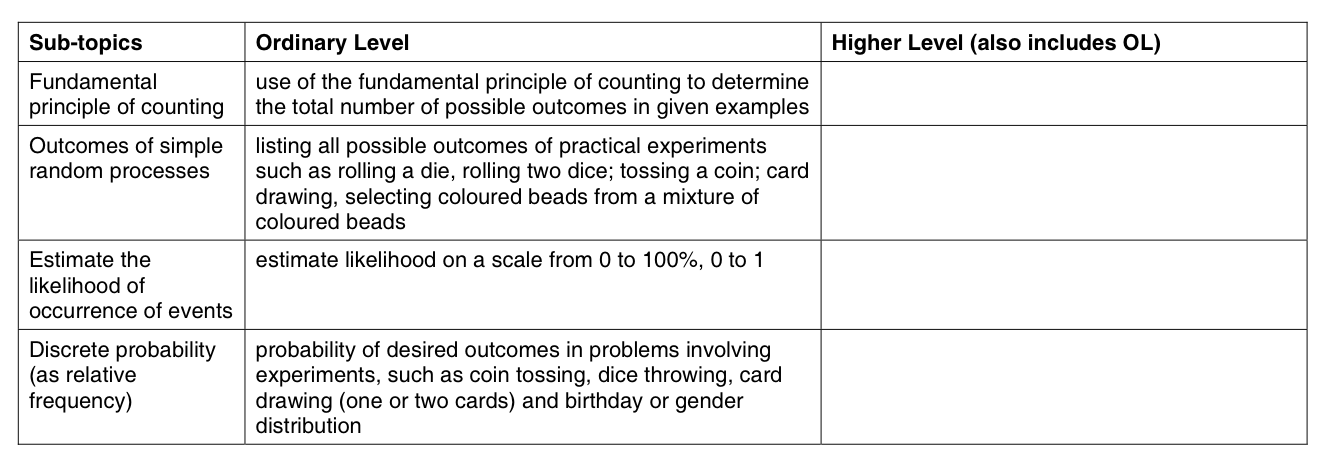
**2. Prior Knowledge**

* Language of Probability
  + Event
  + Outcome
  + Sample Space
  + Trials
  + Probability
  + Relative Frequency
  + Theoretical Probability
  + Equally-likely
* Experimental Approach to probability using a single die
  + Tallying
  + Frequency
  + Relative Frequency
  + Probability as a %
* Fundamental Principle of Counting
  + Working out number of outcomes by listing them
  + Working out number of outcomes by rule

**3. Objectives** (what we are learning today)

* Investigating the probability of outcomes from throwing two dice by experiment
* Investigate the theoretical probability of outcomes from throwing two dice

**What the Syllabus says**



**4. Learning Outcomes**

* Students will know how to carry out an experiment involving two dice
* Students will be able to fill out a two-way table
* Students will be able to create a bar chart showing the probability of each event
* Students will understand that all events are not equally likely
* Students will understand why all events are not equally likely
* Students will be able to work out theoretical probability of a given event

**5. Vocabulary:** Event, Outcome, Trial, Sample Space, Equally likely outcomes

**Resources:** Pair of dice for each group, handout for tallying, handout for plotting graph to show probability of various outcomes, handout of two-way table

**6. Starter**

Explain to the students what we are going to investigate today – the probability of certain events occurring involving two dice.

Explain to them that by understanding probability involving 2 dice they should be able to design their own game so that they will win most of the time. This knowledge may help them stop themselves being conned out of their money.

Can anybody name a game involving 2 dice?

Craps – players bet on outcome of rolling 2 dice

Very popular in U.S. casinos

Developed as a simplified version of the old English game ‘Hazard’

Game thought to date back to Roman times



**Recall outcome of single die experiment**

*1. What is the probability of rolling a 1?*

1/6

*2. What is the probability of rolling a 6?*

1/6

*3. What can you say about all the outcomes when rolling a die?*

They are equally likely.

*4. What can we say about the die if all outcomes are equally likely?*

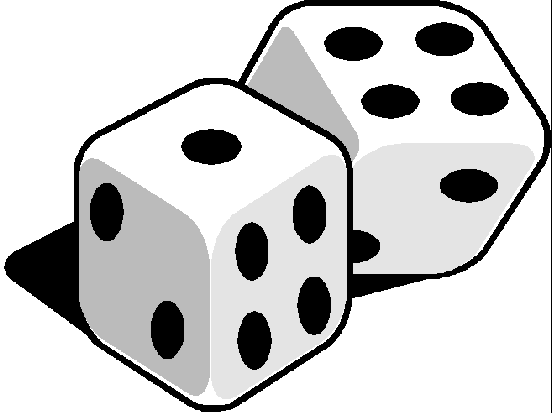
The die is a fair die.

*5. When working out the probability of different outcomes by experiment, how can we make the results of the experiment close to the true (theoretical) probability?*

By increasing the number of trials.

**7. Lesson Plan – Experimental approach to determining probability**

|  |  |  |  |
| --- | --- | --- | --- |
| **Student Learning Activities and Teacher Questions** | **Expected Reactions / Responses of Students** | **Teacher Support & Actions in response to student reactions and things to remember** | **Points of Evaluation** |
| **Task 1**  Roll two dice and add up total.  Each double-roll is a single trial.  Can you list all the possible totals you could get when rolling a pair of die?  Students fill in answer to question 1 on worksheet 1.  If the two dice are fair are all totals (1-12) equally likely (cloze question)?  Students fill in answer to question 2 on worksheet 1. | Students should roll dice fine.  What does that mean?  Totals will range from 1-12  Totals will range from 2-12  Totals will range from 1-6?  Yes all totals are equally likely if the dice are fair – we learned this already when rolling a single dice? | Split students up into groups of 2.  Give a pair of dice to each group.  Give out worksheet 1 to every student. Students must fill out their own worksheet even when working in groups.  Demonstrate what the experiment is about- roll two dice and add up their total. Each double-roll is a single trial.  Emphasise that students should think about this before answering. Discuss the reason for giving your answer with your partner before deciding.  Check that students are filling in answers to Q1 & Q2 before proceeding to experiment.  Write some sample answers to Q1 & Q2 on board.  Get students to explain their answers – particularly if different groups have different answers.  Explain that we will now use experiment to determine which answers are correct. | Do students understand how to carry out a single trial?  Have students filled in answer to Q1? Are there are range of answers from across the class?  Have students filled in answer to Q2? Are there a range of answers from across the class?  Are there a range of answers from different groups?  Can students give reasons why they chose their own answers?  Can students give reasons as to why they disagree with the answers of other groups? |
| **Task 2**  Students complete experiment, carrying out 50 trials  Students fill tallying column of table in worksheet 1.  Students fill in frequency column of table in worksheet 1.  Students check that they have carried out exactly 50 trials.  When above columns are filled in one student from each group comes up and fills in results in master table.  Students complete their own table by filling in relative frequency and probability as a %. | How many trials do I do?  How do I tally?  How do I get the frequency?  How do I check that my number of trials is correct?  How do I work out the relative frequency?  How do I change this to a %? | Circulate to make sure that students understand what they are supposed to be doing  Make sure tallying is being done correctly  Make sure that students are filling in results on their own handouts  Place master table on OHP  Check that each groups’ number of trials is correct.  Demonstrate / Explain how to calculate relative frequency.  Demonstrate / Explain how to calculate %.  Fill in frequency and relative frequency column of master table | Are students able to carry out experiment?  Do students remember how to tally properly?  Do each groups total trials sum to 50?  Do students understand / remember how to calculate relative frequency?  Do students understand how to calculate percentage? |
| **Task 3**  Students examine results of experiment and fill in answers to the following questions on worksheet 1.  Is it equally likely that each roll of the 2 dice will give you a total of 1,2,3,4,5,6,7,8,9,10,11,12?  Which total(s) is (are) most likely when rolling a pair of dice?  Which total(s) is (are) least likely when rolling a pair of dice?  Looking at the master table it is clear that not everybody got the same results.  It may also be the case that it is quite difficult to pick out the answers from your own table.  How could we make the results more reliable / more reflective of the true probability?  How could we increase the number of trials very quickly?  **Use the master table to go back and answer Q4 – Q6**  What is the probability of getting a total of ‘1’ when rolling 2 dice?  Do the results of the experiment agree with your predictions in Q1? Explain your answer.  Do the results of the experiment agree with your predictions in Q2? Explain your answer. | Students may have difficulty answering some questions using their own table.  No, some totals are more likely than others.  No, some totals occurred more than others.  Yes all totals occurred the same number of times.  No, we never got a total of ‘1’.  It’s hard to tell – they all look similar to me  7  6,7,8  5,6,7,8,9  1  1,2,12  1, 2, 3, 11, 12  Yes results are different  Results are not identical but are similar  Yes, my results are difficult to read  Yes, my answers are different to theirs  Increase the number of trials  Repeat the experiment more times  Add each group’s results together  You can’t get a 1  There is no chance of getting a 1  It’s impossible to get a 1  The probability of getting a 1 is 0  Yes – they agree  No they don’t agree  Yes – they agree  No – they don’t agree | Circulate to see what type of answers students are giving.  Help students with any difficulties in understanding questions.  Explain that students should see that some totals are more likely but that each group’s results may not be the same.  Again answers from group to group may differ but the middle totals should be highest for all groups  Results will differ but all groups should get 1 as the lowest probability and the low and high totals as the next lowest probability  Give students time to consider answer  If having difficulty prompt with a question - When we did experiments with a die or a deck of cards, how did we make the experiment results more reflective of true probability?  Fill in / reveal the frequency column and the relative frequency column of the master table.  Give students time to realize why results didn’t agree with predictions or how they managed to predict the correct results. | Have students seen the general pattern in the results of the experiment i.e. that some totals are more likely than others.  Can students observe that the central numbers are more likely while the lower and higher totals are less likely?  Do students recall that more trials brings the results of the experiment closer to the true probability?  Is it easier to pick out the pattern from the master table?  Have students carried out the experiment correctly so that they got no ‘1’ as a result.  Do students realize that getting no ‘1’s means that the probability of getting a total of ‘1’ is zero?  Can students explain why their original predictions were correct / incorrect? |
| **Teacher summarises results of experiment**  Ask students to summarise what they have learned from the experiment.  When rolling two fair dice and adding their totals it is impossible to get a total ‘1’  The probability of getting a ‘1’ when summing the total of 2 dice is zero.  Not all totals are equally likely – a 2 & a 12 are least likely while a total of 7 is most likely.  We made the results of the experiment clearer by increasing the number of trials.  The probability of certain events when dealing with 2 dice is more complicated / different to that for a single die. | | | |

Worksheet 1. Throwing two dice 

1. If you roll two dice in any given trial and add the outcomes together, list all the possible answers you could get.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Assuming that both dice are fair are all outcomes equally likely (i.e. do you have the same chance of getting a total of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12)?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Carry out 50 trials of rolling 2 dice. Add up the total value of both dice for each trial. Fill in your results in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sum of two die | Tally | Frequency (how often this event occurred) |  | Percentage |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |
| 7 |  |  |  |  |
| 8 |  |  |  |  |
| 9 |  |  |  |  |
| 10 |  |  |  |  |
| 11 |  |  |  |  |
| 12 |  |  |  |  |

1. Based on the results of the experiment are all outcomes equally likely? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Based on the results of your experiment, which outcome(s) is (are) most likely when you roll 2 dice?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Based on the results of your experiment, which outcome(s) is (are) least likely when you roll 2 dice?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Based on the results of the experiment, what is the probability of getting an outcome of ‘1’ when you roll 2 dice?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Do the results of the experiment agree with what you predicted in Question 1? Explain your answer.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Do the results of the experiment agree with what you predicted in Question 2? Explain your answer.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Master Table for Worksheet 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sum of two die | Individual Group Results | Frequency (how often this event occurred) |  | Percentage |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |
| 7 |  |  |  |  |
| 8 |  |  |  |  |
| 9 |  |  |  |  |
| 10 |  |  |  |  |
| 11 |  |  |  |  |
| 12 |  |  |  |  |

**Starter**

Explain to students that we are now going to try to figure out why some outcomes are more likely than others.

This may represent the start of a new lesson so it would be a good idea to go back over the basic concepts introduced by the rolling of 2 dice.

Remember that we were playing a game of rolling two dice and we were interested in the total score we got each time we rolled the pair of dice.

We were using two fair dice – so that all numbers on each dice had an equal chance of being rolled.

We found though that when we rolled the two dice for a large number of samples (combining each group in the class’s results) some totals (outcomes) were much more likely than others. For example an outcome of 7 was much more likely than an outcome of 2 or 12.

Many may have found this an unexpected answer since we know from our experiment with a single fair dice, that all outcomes are equally likely.

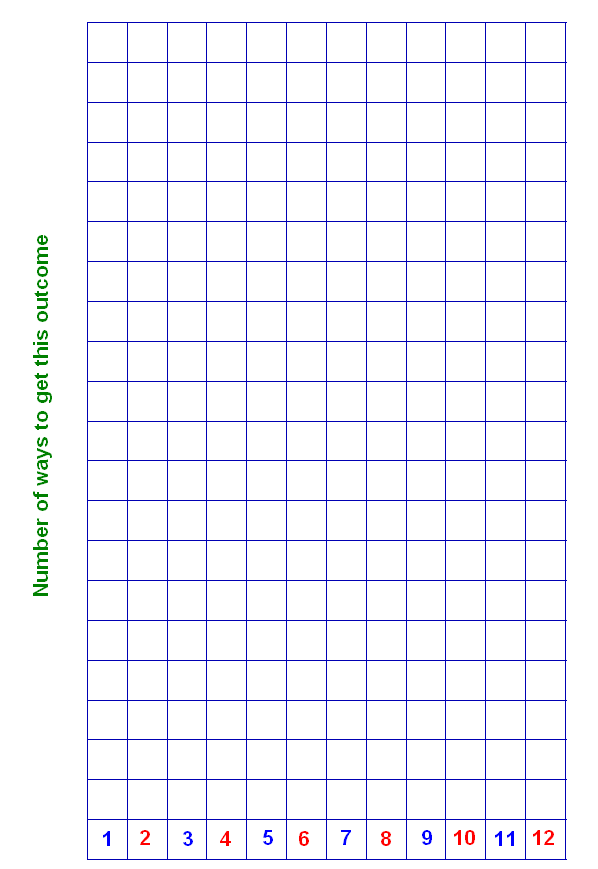
We are going to carry out a simple exercise so we can figure out what is going on in our 2-dice experiment.

**Lesson Plan – Determining Probability using Fundamental Principle of Counting**

|  |  |  |  |
| --- | --- | --- | --- |
| **Student Learning Activities and Teacher Questions** | **Expected Reactions / Responses of Students** | **Teacher Support & Actions in response to student reactions and things to remember** | **Points of Evaluation** |
| **Task 1**  Students fill in worksheet 2 on possible outcomes of rolling 2 dice | What are we supposed to do?  How do we fill this in?  Some students may fill in potential ways of getting a ‘12’ as an outcome incorrectly, using numbers which are not on a die eg. 8+4 | Give a handout of the blank worksheet to all students.  Put a version of the worksheet on the board / OHP.  Explain to students what they are expected to do:   * Above each outcome fill in all the ways of rolling the dice that can give this outcome * When you have all the ways filled in, shade in each of the boxes you’ve written in with a yellow (light-coloured pencil)   Do an example of filling in the worksheet for the number 4 (note 4 has enough ways of being produced to allow students to understand what they have to do)  Circulate around groups to make sure worksheet is being filled in correctly and to spot any potential difficulties with the exercise.  Discuss with students why they are filling in their answers.  Ask students if they are starting to see a pattern developing? | Are students filling in the worksheet correctly?  Are a lot of students confused by what they have to do?  Are students able to explain their reasons for filling in their solutions?  Are students able to see a pattern emerge and can they relate this back to our previous experiment with two dice? |
| **Task 2** Students compare / discuss their solutions  How can you get an outcome of ‘1’? (repeat for each outcome) | Various answers  For an outcome of ‘4’ some students may answer 1+3, 3+1, 2+2 & 2+2 (note there should only be a single 2+2) | Fill in results on master chart on board  Ask different students for each outcome.  Make sure that all groups end up with the correctly shaped chart | Have the class managed to fill out the chart correctly? |
| **Task 3** Students answer questions on worksheet using the chart and the master table / their own table from worksheet 1 | Can I use my own results from the last lesson’s experiment? | Explain to students that they need to use the results of our experiment from the last lesson as our aim was to explain its results  Place master table from experiment 1. on board / OHP alongside completed outcomes chart  Circulate to check on student difficulties  Students work in groups and must have same answer filled in as partner. If there is disagreement on answer they must discuss it and come to a common solution. | Are students capable of answering the various questions? |
| **Task 4** Discuss results of answering questions in class  Is there an equal number of ways to get all outcomes?  How many ways are there to get a ‘1’?  Which outcome has the least number of ways of happening (apart from 1)?  Which outcomes occurred least often in experiment 1 with the two dice (excluding 1)?  Can you explain why 2 & 12 occurred least often in our experiment?  Which outcome has the most ways of happening?  Which number occurred most often during our experiment?  Can you explain why the number 7 occurred most often during our experiment in the last lesson?  In a couple of sentences can you explain why, in our experiment with 2 dice, not all outcomes are equally likely?  If the students have carried out games involving different numbers of differently coloured cards it would be good to relate the outcomes of this experiment to those results:  In a game with 2 red balls, 5 green balls, 7 yellows and 10 blues – if you keep drawing balls from a bag and replacing them, which colour is most likely to be drawn? Which colour will be drawn most often?  Why would this be so?  Explain that this is similar to the 2-dice experiment. There are more ways of making a ‘7’than a ‘1’ or a ‘12’, so a 7 is more likely or will occur more times. | No, some outcomes have more ways of happening than others?  No some outcomes are more likely than others?  None / zero / impossible  2 / 12 / 2 & 12  2 / 12 / 2 & 12  There are less ways of getting a 2 & 12 than other outcomes?  7  7  There are a lot of ways of making up a 7?  A 7 is more likely because it can be made up several ways  A 7 is easy because you can make it up with lots of numbers  Some outcomes occur more than others because there are more ways of getting these outcomes with two dice.  Some outcomes are more likely because they are easier to make using 2 dice.  Some outcomes don’t appear often because they are difficult to get.  Some numbers don’t occur much because it’s not as easy to make them using 2 dice.  The colour Blue  There are more blue balls than any other colour.  You’ve a better chance of blue because there’s more of them | How do you know that there are more ways of getting some numbers than others?  Would you have thought that this was true before doing the chart out?  Why are there no ways of getting an outcome of ‘1’?  If you can’t see from your results, use master table.  Why do we use master table?  More trials so the results are closer to true probability  Are there a lot of ways to make a 2 & 12 using 2 dice?  Refer to bar chart on board  Use master table from experiment 1 to read off answer  What do you notice about the number of ways of making up a 7 compared to the number of ways of making up, say a 1 or a 12?  Give students time to go back and attempt this question now that we have discussed some of the results?  Students decide on answer in pairs.  Circulate to offer help to those who are having difficulty.  Explain to students to look at the results in master table and the bar chart and see if there is any connection? | Answer correctly?  Is there a general understanding of what the bar chart says?  Do students understand that the minimum you can get on each die is ‘1’so the minimum total of two dice is ‘2’?  Are 2 & 12 appearing as the answer to both questions  Can students make the link between the number of ways in which a particular outcome can occur and the number of times it did occur in experiment?  Can students make the link between the number of ways of getting an outcome and the number of outcomes during experiment?  Can students put together a simple and coherent explanation as to why some outcomes re more likely than others?  Can they use the language of probability when writing down their answer?  Do students remember experiment and have they retained their understanding?  Can students see the link between the coloured-ball experiment and this lesson’s experiment? |
| **Task 5** Students work out the probability for each outcome using 2 dice  How many possible outcomes are there for the experiment involving 2 dice?  What is the probability of getting an outcome of 2?  Can you work out the probability for the various different outcomes listed? | 11  12  36  How do we do that?  1/11  1/36  What do I do?  Do I do the same as we just did? | Give out copy of worksheet 3 to all students.  Explain to class that they may use worksheet 2 to work out the answer.  Put copy of worksheet on OHP.  Ask class for solutions to Question 1?  Get a mixture of answers.  Take a straw poll of answers presented.  Explain to class how to find the number of outcomes (count the yellow squares).  Link back to the probability of drawing a certain card from a deck.  Ask class if they can remember how they worked out the probability then?  Go through sample calculation on copy of worksheet on board  Students work in pairs.  Circulate to help those having difficulties.  Question students as to their method.  Explain to students that they should simplify fractions and calcualte percentages if time permits. | How many students figured out how to get the number of outcomes?  Did any students remember how to do this calculation?  Were students able to relate method of calculating probability for cards to the two-dice experiment?  Can students work through calculations without assistance?  Can students work through later calculations without template?  Can students remember how to simplify fractions and convert a fraction to a percentage? |
| **Task 6** Apply knowledge in the design of a game involving 2 dice, where the probability is stacked in your favour.  If you used a game with one dice and you told your playing partner that they would win euro 1 everytime a 5 was drawn, while you would win euro 1 everytime a 1, 2 or 4 was drawn, would they take you up on the game?  We have just learned that probability with 2 dice is not as straight forward. Could you use this to design a game simillar to the one above, but involving 2 dice, where the odds of winning are stacked in your favour?  Students make posters with title of game, with rules and explaining the reasons behind their choice of game. | No – it’s clearly unfair  Various | This may be given as a homework exercise or an in-class exercise.  If done in class – circulate to get an idea of possible games.  Help students to develop a strategy for designing a game. | Are students capable of designing their own game?  Can students explain their reasoning behind their game choice?  Can students apply the knowledge learned to design optimum game in their favour?  Is there variety in the various designs proposed? |
| Teacher summarises results of investigation  In a game with 2 fair dice – all outcomes are not necessarily equal  The reasons for this are that some outcomes can result in a greater numbre of ways  e.g. Outcome of 2 can only result from a 1+1 (one possible way)  e.g. Outcome of 7 can result from a 1+6, 6+1, 2+5, 5+2, 3+4, 4+3 (6 possible ways)  The more favourable outcomes there are the more likely one is to occur  Games involving 2 dice are more complex than that with on die. | | | |

Worksheet 2 - Throwing 2 dice

1. In the table below fill in all the ways in which each outcome can be produced, in a separate box above each out



1. From your chart is there an equal number of ways to get all outcomes?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. From your chart how many ways are there to get an outcome of ‘1’?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Looking back at worksheet 1, how many ‘1’s’ did we get as an outcome in our experiment?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Based on what you now know, can you explain why we got no outcome of ‘1’ during our experiment?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. From you chart, apart from 1, which outcome has the least number of ways of happening?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Looking back at our master table from worksheet 1, apart from ‘1’, which outcomes occurred least often?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Using the above chart, can you explain why these numbers occurred least often?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. From your chart, which outcome has the most ways of happening?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Looking back at our master table from worksheet 1, which outcome occurred most often?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

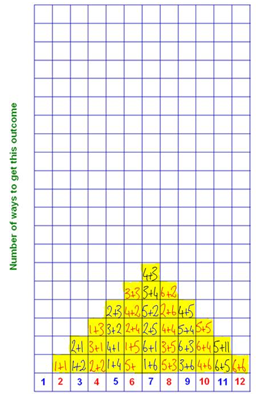
1. Using the above chart, can you explain why this number occurred most often?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. In a couple of sentences, could you explain why, in our experiment with two fair dice, not all outcomes are equally likely?

|  |
| --- |
|  |

Sample Solution to 2-Dice Bar Chart



Worksheet 3 – Probability of various outcomes for rolling 2 dice

1. From your chart in worksheet 2, count the total number of outcomes for the experiment

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. We will now use this answer to work out the probability of getting different outcomes:

|  |
| --- |
| What is the probability of getting an outcome of 2?  There are \_\_\_ outcomes in total for this experiment.  There are \_\_\_ ways of getting an outcome of 2.  The probability of getting an outcome of 2 is therefore: |

|  |
| --- |
| What is the probability of getting an outcome of 4?  There are \_\_\_ outcomes in total for this experiment.  There are \_\_\_ ways of getting an outcome of 4.  The probability of getting an outcome of 4 is therefore: or or \_\_\_ % |

|  |
| --- |
| What is the probability of getting an outcome of 7?  C:\Documents and Settings\sgammell\Local Settings\Temporary Internet Files\Content.IE5\ON8GM7QT\MCj04245820000[1].wmf |

|  |
| --- |
| What is the probability of getting an outcome of 8  C:\Documents and Settings\sgammell\Local Settings\Temporary Internet Files\Content.IE5\ON8GM7QT\MCj04115220000[1].wmf? |

|  |
| --- |
| What is the probability of getting an outcome of 11?  C:\Documents and Settings\sgammell\Local Settings\Temporary Internet Files\Content.IE5\ZU1MGBSP\MPj04074220000[1].jpg |

Worksheet 4 – Design your own 2-dice game

You are asked to design a game involving 2 dice, based on the ideas investigated in Worksheet 1 and Worksheet 2.

You will play the game against somebody who has not studied probability like you have.

To help you start with the design of your game here’s a hint as to how you would intriduce the game to the other person: *“I have 2 dice and we will now play a game. Each time we roll the dice we will count up the total of the 2 dice. Every time we get a total of ……… I win €1, while evertime we get a total of ………, you win €1*”

Your aim is to design a game which appears to be fair to the other person but which is really unfair and will make sure that you win the game.

You could try this game out with a parent – but make sure you give them their money back at the end and explain to them how you won.

Good luck!!