

## That's the way the cookie crumbles

### Purpose:

The purpose of this multi-level task is to engage students in an investigation that leads to the comparison of experimental probability, with a theoretical probability.

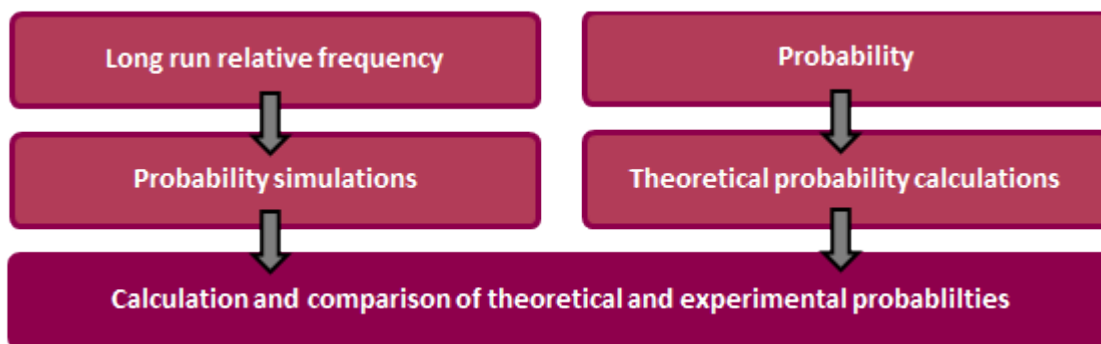
### Achievement Objectives:

S5-3: Compare and describe the variation between theoretical and experimental distributions in situations that involve elements of chance.

S5-4: Calculate probabilities, using fractions, percentages, and ratios.

### Description of mathematics:

The background knowledge presumed for this task is outlined in the diagram below:



This task may be 'scaffolded' with either a focus on following the procedures given, or it may be given as an opportunity for students to design their own simulation. The approach should be chosen in sympathy with their skills and depth of understanding.

### Activity:

Task: A bakery is producing cookies for a fundraising drive. The cookies come in packs of 5.

A fault in the design of the machinery means that one in every ten cookies crumbles when packed.

Model this process to work out an experimental probability of getting exactly two crumbled cookies in a pack.



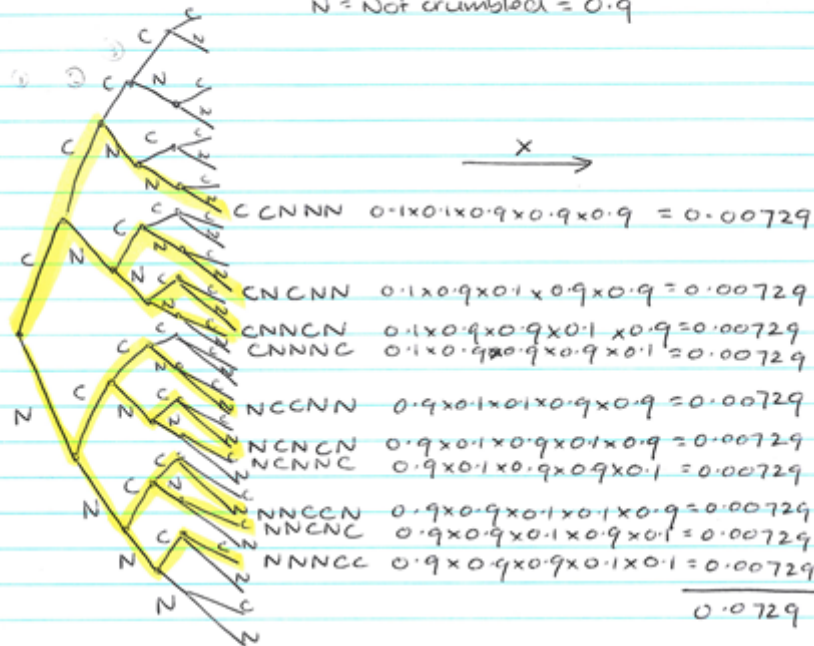
Compare your experimental probability with the theoretical probability of getting two crumbled cookies in a pack.



### Theoretical Probability

C = Crumbled = 0.1

N = Not crumbled = 0.9



Probability that 2 out of 5 cookies in a pack will be crumbled = 0.07

Experimental Probability was = 0.08

These values are almost the same

T: Which one is the most accurate?

S: The theoretical one, because it uses exact values, but it was harder to work out.

T: So when might experimental probabilities be more practical to use?

S: When it is too hard to work out the theoretical ones ... or maybe if we did a lot more trials we would have lucked on the same probabilities.

## The conceptual approach

The student is able to design and carry out a simulation to generate a probability and to compare this value with their calculated theoretical probability.

Prompts from the teacher could be:

1. Run a simulation to model a large number of packs of cookies. You can use Ran# on your calculator to generate random numbers. Set up your calculator to generate random numbers that represent the cookies in a pack. An appropriate number of digits can be chosen to represent the crumbled cookies.
2. Calculate the experimental probability from your simulation.
3. Calculate the theoretical probability for exactly two cookies in a pack to be crumbled.
4. Compare the two probabilities that you found.

T: Tell me how you generated these numbers and what they mean.  
 S: I used random numbers on my calculator and went 100 000 times the random number to get a 5-digit number. Each of those digits represents a biscuit and if I get a 3 then it means it is crumbled.  
 T: And you did this 50 times?  
 S: Yeah – I thought that would be enough. But it didn't take that long and I probably should have gone for 100 to get closer to 0.07.

Boy Scout Cookies - 3 = crumbled

55278	78994	07892	44212	86620
67077	24415	34666	54833	16970
00026	91405	02362	52883	45765
55303	28062	33619	57068	88782
46132	55844	51039	88559	96148
48029	49993	92917	57740	93690
01388	72974	55468	92277	70758
36840	20916	11687	35868	51127
12476	81826	80552	34408	86520
04723	60152	85210	63040	85832

Packs with 2 crumbled cookies - 3/50  
 Experimental Probability 0.06

Theoretical Probability

$$\frac{1}{10} \times \frac{1}{10} \times \frac{9}{10} \times \frac{9}{10} \times \frac{9}{10} \times 10 = 0.0729$$

- CCFFF
- CFCFF
- CFCCF
- CFFFC
- FCCFF
- FCFCF
- FCFFC
- FFCCF
- FFCFC
- FFFCC

These probabilities are similar. In theory I would expect 7 packs out of 100 to have 2 crumbled cookies in it. That would be 3.5 packs out of 50; but I'm only allowed whole packs so I'd expect 3 or 4 and I got 3

T: Tell me about these Cs and Fs.  
 S: C means crumbled and F means fine. I looked at all the possible ways a pack could be arranged if exactly two were crumbled. There are 10 different ways.  
 T: And how did you use that 10 in your calculations?  
 S: I found the chance of getting two crumbled and three fine and then timesed that by the 10 different ways this can be arranged.