



## Probability & Scratch

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*Probability & Scratch* is a task created with the goal of teaching probability by using computational thinking concepts to help students grasp a new and abstract math topic concretely. It was designed for a Grade 7 or 8 level according to the Ontario Math Curriculum, but could be adjusted for other levels.

*“Students were all busy and doing various tasks so student learning was certainly differentiated and they could work through at their own pace.”*

*“Many students asked if they were doing coding or math? They really had not considered that the two were connected before. I think bringing awareness that there is math in coding and not just in math class was evident.”*

(teacher comments, April 2018)

### Description of Activity

*Probability & Scratch* is comprised of a set of worksheets outlining 4 steps combined with two online Scratch programs. The students will need access to dice and a computer. The activity is designed to be a student lead exploration with teachers giving clarification or guidance as needed.

Step one guides the students through a typical classroom simulation using 6 sided dice. It also includes a section for the students to describe what they are doing when rolling the dice. This is an important step in learning to communicate explicit steps for another student or computer to recreate.

Step two builds on step one by showing the students a program on Scratch which simulates rolling a dice. This shows the students how a real-life activity can be translated onto the screen using coding and introduces them to the idea of using coding for math exploration in Scratch.

Step three uses the same program as step two to develop the idea of theoretical probability. Students are asked to modify the code so that they can roll the dice simulation 100 times. This helps the students understand the idea of experimental probability tending towards theoretical as the number of simulations increases. It also builds their understanding of the use of computer simulations as they can imagine how long it would take to roll the dice 100 times by hand.

Step four moves on to a problem involving two independent events. In this part of the activity the students are given part of a code and are required to build the rest in order to determine the probability. This requires an understanding of how the computer (Scratch) counts the events and how the probability is calculated which the students have explored in previous steps.

### Learning Objectives

- Primary
  - Making predictions for real life
  - Creating inferences and arguments based on data
  - Understanding theoretical and experimental probability

- Secondary
  - Comparing problem solving strategies
  - Communicating mathematical thinking
  - Using multiple number representations

### **Math Topic & Curriculum**

The math topic associated with this activity is probability. This activity specifically aims to meet the following expectations from the Ontario Ministry of Education Curriculum documents:

*By the end of Grade 7, students will: report on real-world applications of probabilities expressed in fraction, decimal, and percent form; perform a simple probability experiment involving two independent events, and compare the experimental probability with the theoretical probability of a specific outcome*

*By the end of Grade 8, students will: compare, through investigation, the theoretical probability of an event with experimental probability, and explain why they might differ; determine, through investigation, the tendency of experimental probability to approach theoretical probability as the number of trials in an experiment increases, using class-generated data and technology-based simulation models (MoE 2005)*

The grade 7 expectations are met by leading each student to use multiple number representations in the worksheet as well as in the Scratch programs which show the formula for the experimental probability using a fraction, percent, and decimal. The second scratch program explores an experiment involving two independent events. The grade 8 expectations are met through exploring the theoretical and experimental probabilities from both the worksheet and two Scratch simulation activities.

### **Technology & Project type**

This activity was developed using [scratch.mit.edu](http://scratch.mit.edu), a free online programming tool designed to be friendly to all ages and levels of coding. The type of activity is a step-wise programming task. The goal of this type of project is to guide students through an activity which uses coding to develop mathematical ideas and allow students to discover the lesson through their own creative thought. For this *Probability & Scratch* activity students are expected to be familiar with the Scratch environment.

### **Implementation**

*Probability & Scratch* was designed to be used across multiple lesson periods with the option for peer collaboration. However, it can be implemented in a variety of ways depending on the needs of the class. As the activity is a non-traditional introduction to probability multiple lesson periods allow the students time to reflect on what they have learned and then make adjustments to their method. Additionally, as it is a student lead exploration they may find it frustrating to not know the answers immediately so breaking the activity into smaller pieces may be helpful. Partner or group collaboration is encouraged as it allows the students to practice their mathematics communications as well as bounce ideas off each other and learn from their peers. To provide extra guidance or structure to the activity an example could be projected at the front of the classroom for students to follow along with on their own work. However, the students should still be providing the ideas for how to answer the questions or coding problems that are projected. As the worksheet is self-explanatory, this task could also be used as a complementary activity for students to work on individually between other activities during their day. In total this activity should be given at least 3 hours for completion.

## Mathematics Engagement

Mathematical engagement is central in this task. Probability is the main source of engagement as it is the topic of exploration for the students. The students will gain an understanding of how to complete a probability experiment as well as the idea of a theoretical probability. They will be able to explain how these two types of probability are linked. Throughout the task students are working with a variety of number representations. The worksheet and Scratch program demonstrates the fact that using a division sign is the same as a fraction. Additionally, the students convert to percent by multiplying their fraction by 100% and see the result as a decimal.

Through the use of Scratch and computational thinking in this activity the students may gain a sense of agency during this task as they work through the lesson and create their own learning. When they are done the worksheet, they will be able to use the program they completed to show their results and describe how they arrived at their conclusions. This may not only give the students a sense of pride in their work, but can add to the depth of their understanding as they have the opportunity to see probability as something tangible that they now are able to model. The abstract concept of probability may come to life with the simulations that students explore. This activity also allows students to work at their own pace and use their strengths in order to reach a solution. Lastly, the Scratch programs can be adjusted for any skill level allowing for a low floor starting point, but also creating the high ceiling opportunity for students to build on their learning and make the program more complex to model more probability questions.

## Resources

Probability and Scratch Worksheets (pdf)

Programming Files:

Step 2-3 Dice Activity: <https://scratch.mit.edu/projects/237147913/>

Step 4 Tile Activity: <https://scratch.mit.edu/projects/237152318/>

Step 4 Complete - for teacher use: <https://scratch.mit.edu/projects/237153388/>

I would love to hear from you! If you try *Probability & Scratch* in your classroom or for more information about this task contact **Kirstin Dreise** – [kirstindreise@gmail.com](mailto:kirstindreise@gmail.com)

The MKN is funded by the Ontario Ministry of Education. The MKN is a KNAER Project hosted by the Fields Institute for Research in Mathematical Sciences. The views expressed in this document belong to the authors and do not necessarily reflect the opinions of the Ministry of Education nor the Ontario government.



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