MICE DICE – TEACHER'S GUIDE

USCOTS 2023

Overview

The Mice Dice activity can be used to target any or all of the following objectives and can be reasonably adapted to any grade level from 5th grade through post-secondary. Objectives that might be targeted include:

1. **Conceptual**
    a. Observe and describe the differences between empirical and theoretical probabilities.
    b. Identify (and implement) a mechanism to simulate a process to produce empirical data.
    c. Understand the impact of the Law of Large Numbers when sampling.
    d. Ideas in probability (total probability 1, adding probabilities for non-overlapping outcomes, multiplying probabilities for joint outcomes)
2. **Computational**
    a. Compute **empirical probabilities** based on a sample.
    b. Compute **theoretical probabilities** using **tree diagrams**.
3. **Graphical**
    a. Construct Tally Tables
    b. Construct Tree Diagrams

The activity could also be incorporated into science curriculum and discussions of genetics.

Unless otherwise specified, my comments below are from the perspective of using this activity with college students in a general education class. Most of the students in that class are on track to become elementary school teachers.

Page 1

- In my class, I spend about 5 minutes talking briefly about the terms in the background section. The most important terms (the ones that they need to use to do the activity) are allele, genotype, and phenotype. Of course if it were desired to implement this activity in a manner that also covers science objectives, the background section and the class-time allocated to it could certainly be extended.
- The remainder of page 1 has the class thinking through the process of simulating. There is room for variance in process, however it should be something equivalent to:
    - The dice are different colors so that one color can represent the father mouse and the other can represent the mother. In the first simulation, this doesn't technically impact results at all, but it will be relevant later in the activity.
    - In this simulation, the dominant allele (F) and the recessive allele (f) are equally likely to be passed from each parent. Thus students may let odd rolls represent "F" and even rolls represent "f". There are of course many ways to do it – so long as three of the numbers on each die are designated to represent each of the two possible alleles.
    - Question 2C is designed to get students thinking about how to handle issues fairly in a predetermined fashion. For example, what will happen if one of the dice is rolled onto the floor instead of the table? What should happen if one of the dice lands in an angled fashion partially resting on a notebook?
- I typically give 5 minutes for groups to discuss and identify how they will sample before leading a short discussion and idea sharing with the entire class. That is an important step to ensuring that everyone in the class is proceeding with a reasonable mechanism of sampling.

Page 2

- This page begins with the students implementing their simulations using the dice. Depending on the level of the class and what has previously been discussed, there may be needs for explanation of using Tally marks, and calculating the frequency and relative frequencies needed in the table once the tallies are complete.
- Once everyone has finished their data tables, I take another 5-10 minutes to go over some of the statistical terms (students often have already been looking at those definitions as they fill in their data).
- Finally, we discuss tree diagrams leading into page 3 – and I illustrate the pieces that have already been filled in. (See next page)

Page 3

- This tree is very basic, but for my class it's also the first time they've seen anything like it. We introduce terminology such as node, branches, as well as the concept of adding "sets" of branches yielding 1, and multiplying across branches to combine different "actions". We talk about that the second sets of branches might be completely independent of the first (i.e. the same for each "set"); or they might be different depending on what occurred at the first branch (i.e. conditional). While we won't talk about conditional probability or independence until later in the course, they are getting their first taste of the concepts here (i.e. thinking about when should they add, when should they multiply).
- Students are then asked to try to fill in each of the items on this page, after which we discuss each of them as a class to make sure everyone stayed in the correct lane.
- Finally, students are asked to consider the three questions at the bottom, first in their small groups and then again as a class. The primary focus here is on the implications of the law of large numbers to the sampling they have just completed.

Pages 4 and 5

- The base activity having been completed, students are moved on to extensions where probabilities for the dominant and recessive alleles are varied from ½.
- I always ask them to recreate the process for at least two extensions so that I can be sure they are correctly designing and using the tree diagrams to create their probability distributions. They are more or less on their own to do this within the class session, while the instructor monitors to answer questions and/or intervene as necessary to advance student understanding of the material.

Follow-up

Homework questions, e.g. related to drawing marbles from a bag of colored marbles, extend things to:

- More than 2 branches in a set (i.e. 3 colors of marbles)
- Drawing without replacement
- Using counts rather than fractions on the branches (and converting to probabilities at the end)