

**Color Probability of M&Ms**

By: Taylor Rademacher and Dylan Antes

Our study was conducted on the probability of drawing M&Ms out of a bag. In the bag, there were 6 brown, 4 yellow, 4 red, 2 orange, 2 green, and 2 blue M&Ms. Below is the sample space for our study:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Brown | Yellow | Red | Orange | Green | Blue |
| Brown | Br Br | Y Br | R Br | O Br | G Br | Bl Br |
| Yellow | Br Y | Y Y | R Y | O Y | G Y | Bl Y |
| Red | Br R | Y R | R R | O R | G R | Bl R |
| Orange | Br O | Y O | R O | O O | G O | Bl O |
| Green | Br G | Y G | R G | O G | G G | Bl G |
| Blue | Br Bl | Y Bl | R Bl | O Bl | G Bl | Bl Bl |

For the first simple event, or drawing of M&Ms, the color drawn was brown. The P(A) of this event is 3/10, or 30%. The P(A) of the simple event means that there is a 30% chance that we will draw a brown M&M from the bag. The Ac would be drawing any other M&M besides a brown one. The P(Ac ) of drawing a brown M&M from the bag is 70%. The truth about A and A complement is that they add up to 100%, because A and A complement must add up to 100% because the events are the opposite of one another.

For the second simple event, or drawing of M&Ms, the color drawn was red. The P(B) of this event is 4/19, or 21%. The P(B) means that there is a 21% chance that we will draw a red M&M from the bag. The Bc would be drawing any other color M&M besides a red one from the bag. The P(Bc ) of drawing a red M&M from the bag is 79%. The truth about B and B complement is that they add up to 100%, because B and B complement must add up to 100% because the events are the opposite of one another.

 For two events to be independent the occurrence or nonoccurrence of one event does not change the probability that the other event will occur. For two events to be dependent then we have to take into account the changes in the probability of one event caused by the occurrence of the other event. Our two events are dependent because after we draw one M&M, it affects the probability slightly of what the next color drawn will be. By not putting the M&M back into the bag we know that the two events have to be dependent because the probability changes throughout the drawings.

The P(A and B) would be P(A) x P(B I A) giving us the probability of both A and B to be 6.3%. To decide which formula to use we knew that our events were dependent and that is multiplication because it used the word “and”, so the formula for multiplication independent events is P(A) x P(B I A). In terms of our original scenario the 6.3% means that we have a 6.3% chance of drawing a brown M&M on the first draw and a red M&M on the second draw. Since our events were dependent the P(B I A) means what is the probability of drawing a red M&M given that we have already drawn a brown one. For the P(A I B) it means what is the probability of drawing a brown M&M given that we had already drawn a red one.

 For two events to be mutually exclusive it means that the outcome of the first event cannot affect the outcome of the second event. Our events are mutually exclusive because an M&M cannot be two different colors at the same time. In other words, an M&M cannot be both red and blue. The P(A or B) would be 0.30+0.21=0.51, meaning the probability of A and B is 51%. We decided on which formula to use because we knew that our event was mutually exclusive and the addition rule for non-mutually exclusive events is P(A)+P(B), so we used that formula to give us a 51%. This means that there is a 51% chance that we either get a brown M&M or a red M&M with the given amount of M&Ms in a bag. If our events were not mutually exclusive, the significance of P(A and B) is after we added the probability of drawing a brown and then a red, the end result would be 0.

The multiplication rule of counting is the number of potential outcomes for a sequence of events. It is used for finding the total number of outcomes in a sample space, especially for large data sets where it may be tedious to use a tree diagram, such as determining different class schedules or possibilities for taking a class on a field trip. In regards to the field trip, a teacher may want to take their class to the zoo. There are four bird exhibits, three exhibits, and six fish exhibits. Therefore, by using the multiplication rule of counting, the teacher is able to determine that there are 72 possible outcomes for how the class views the exhibits at the zoo.

A permutation counts the number of ways an arrangement of certain values can occur within a data set. A permutation is different than a combination because, while a permutation counts the number of arrangements of items of a distinct data set, a combination only counts the number of groups within a data set. It is used to determine the number of ordered arrangements for a certain selection of objects in relation to the entire group. Some of the methods for calculating permutation are using the formula *Pn,r = (n!)/(n-r)!* or using the *nPr* function on a calculator. A permutation could be used to determine the possible arrangement of how five students are ordered in the Top Ten of their class. Using the formula *Pn,r = (10!)/(10-5)!*, a person could determine that there are 30,240 possible arrangements for the order of the five students in the Top Ten.

A combination counts the number of ways that values can occur within a data set. A combination is different than a permutation because, while a combination only counts the number of groups within a data set, a permutation is more specific and counts the number of arrangements of items of a distinct data set. It is used to determine the amount of different groupings for a possible situation. Some of the methods for calculating combinations are using the formula *Cn,r = (n!)/r!(n-r)!* Or using the *nCr* function on a calculator. A combination could be used to determine the possibilities for a person purchasing insurance plans. If there are eleven plans to pick from, and a person must choose five from those plans, they could use the formula *Cn,r = (11!)/5!(11-5)!*. They could then determine that there are 462 different types of insurance plans that can be selected from the list of eleven.