Sweetening Statistics

What M&M's Can Teach Us

Nearly everyone enjoys M&M's®. But not everyone feels the same way about learning statistics—in fact, some of us actually fear it. However, these tiny sweets give teachers and trainers an ideal way to make statistics more appetizing and immediately understandable.

Students may scratch their heads when you hand out packages of candy. But by simply weighing a few bags of peanut M&M's and counting their contents, they will be gathering useful data.

They then can apply statistics to their own data to answer questions about the M&M's weight, color, quality, and other factors. And, of course, eating the candies after they've analyzed the data can provide additional incentive.

Are the M&M's weights accurate?

According to the package, each small bag of peanut M&M's should weigh 49.3 grams. To determine if the bag weights are on target, ask the students to measure the weight of say, 30 bags of M&M's and conduct a 1-sample t test.

One-Sample T: Weight(g)

```
Test of mu = 49.3 vs not = 49.3

Variable    N    Mean  StDev  SE Mean
Weight(g)  30  52.040  2.807    0.512

Variable        95% CI             T      P
Weight(g) (50.992, 53.088)  5.35  0.000
```

Results generated using **Stat** > **Basic Statistics** > **1-Sample t.**

In our analysis, the t-test results include a very small p-value of 0.000. Since the p-value is much smaller than an α-level of 0.05 or even 0.01, we can reject the null hypothesis and conclude that the average bag weight is *not* equal to 49.3 grams.

In this case, however, it's good news for consumers—we can see from the average weight of 52.040 grams that in fact, the average bag weight is significantly *more* than the 49.3 grams target.

Can two people measure the same weights?

If one person measures 30 bags of M&M's and their friend measures the same 30 bags using the same scale, will they get similar measurements? Students can test this hypothesis using a paired t test.

Paired T-Test and CI: Person1, Person2

```
Paired T for Person1 - Person2

              N       Mean     StDev   SE Mean
Person1      30     52.040     2.807     0.512
Person2      30     52.047     2.802     0.512
Difference   30   -0.00700   0.04435   0.00810

95% CI for mean difference: (-0.02356,
   0.00956)
T-Test of mean difference = 0 (vs not = 0):
   T-Value = -0.86  P-Value = 0.394
```

Results generated using **Stat** > **Basic Statistics** > **Paired t.**

In our analysis, the p-value of 0.394 is larger than our chosen α-level of 0.05. Therefore, we fail to reject the null hypothesis and can conclude that there is not a significant difference between the average measurements taken by the two friends.

Do enough M&M's have the "m"?

M&M's are easily identified by the signature "m" printed on each piece of candy. It must pose a challenge to stamp the familiar symbol on a surface as uneven as a peanut M&M. It's not surprising, therefore, that sometimes this "m" is not perfectly printed.

Suppose there is a requirement that no more than 15% of M&M's have a misprinted "m." If we count the total number of M&M's and the number with misprints, we can conduct a 1 proportion test.

Test and CI for One Proportion

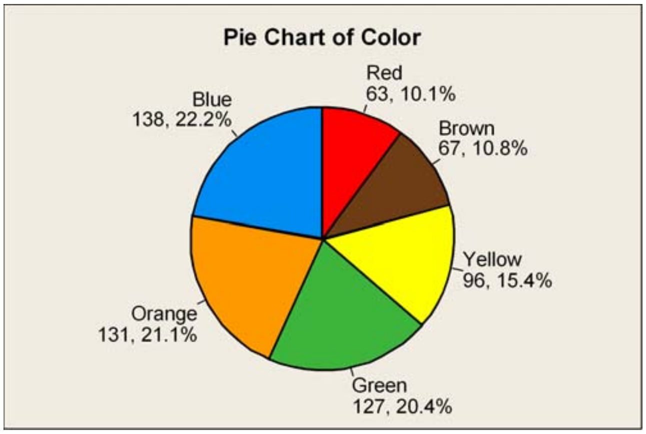
```
Test of p = 0.15 vs p > 0.15


                                    95% Lower
Sample    X    N  Sample p              Bound
1        87  622  0.139871           0.117497


            Exact
Sample    P-Value
1           0.776
```

Results generated using **Stat** > **Basic Statistics** > **1 Proportion.**

Of the 622 M&M's we evaluated for this article, 87 had misprints. Using a 1 proportion test and an alternative hypothesis of greater than 15%, we get at p-value of 0.776. Because the p-value is greater than an α equal to 0.05, we can conclude that the proportion of misprinted M&M's is 15% or less.

Are there equal amounts of each color in a bag?

A pie chart lets us easily visualize the counts of each color.



Graph created using **Graph** > **Pie Chart**.

For example, there were 138 blue M&M's and only 63 red M&M's in our sample. But is the difference between these counts statistically significant? A Chi-square test can tell us.

Chi-Square Goodness-of-Fit Test: CountPerColor

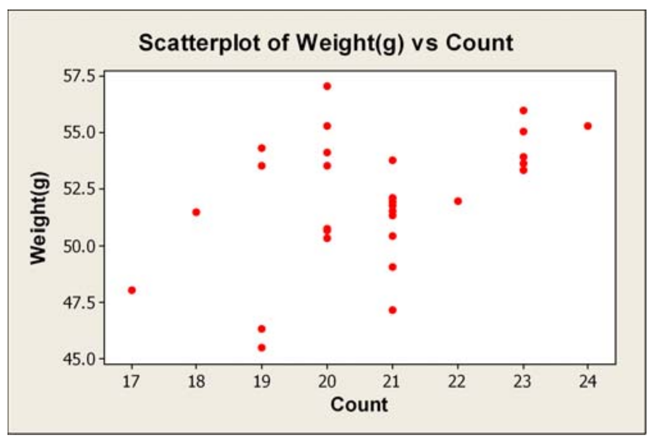
```
Using category names in Color

                             Test
Category  Observed     Proportion   Expected
Red             63       0.166667    103.667
Yellow          96       0.166667    103.667
Orange         131       0.166667    103.667
Blue           138       0.166667    103.667
Green          127       0.166667    103.667
Brown           67       0.166667    103.667

          Contribution
Category     to Chi-Sq
Red            15.9528
Yellow          0.5670
Orange          7.2069
Blue           11.3708
Green           5.2519
Brown          12.9689

  N  DF   Chi-Sq  P-Value
622   5  53.3183    0.000
```

Results generated using **Stat** > **Tables** > **Chi-Square Goodness-of-Fit Test (One Variable).**

The p-value of 0.000 suggests that the observed counts are significantly different than what we would expect to see if there were an equal number of red, orange, yellow, green, blue and brown M&M's.

Is there a correlation between the number of M&M's in each bag and the bag weights?

You may suspect that as the number of M&M's in each bag increases, so does the weight of the bags. We can use a scatterplot to examine this relationship and a correlation test to see if this theory is true.



Graph created using **Graph** > **Scatterplot.**

Correlations: Weight(g), Count

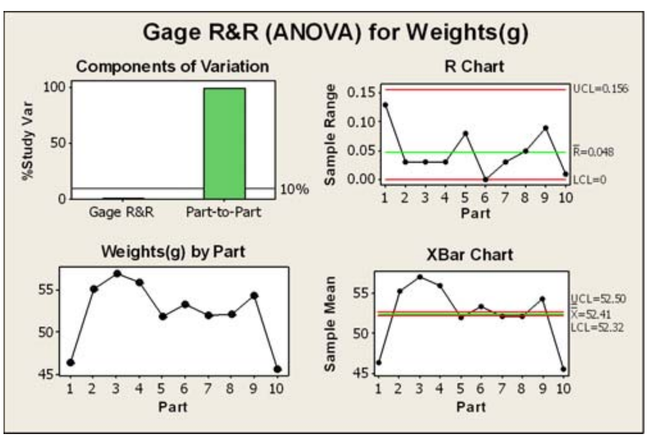
```
Pearson correlation of Weight(g) and
     Count = 0.458
P-Value = 0.011
```

Results generated using **Stat** > **Basic Statistics** > **Correlation.**

The scatterplot of our data shows that, in general, as the number of M&M's in a bag increases, so does the weight. In addition, the correlation p-value of 0.011 indicates that we can reject the null hypothesis and conclude that there is a significant positive, linear relationship between the bag weights and the number of M&M's inside.

Additional Considerations

Although measuring Gage repeatability and reproducibility is well beyond the scope of a typical university statistics course, you can also use M&M's to teach more advanced statistical techniques. For instance, we used Minitab to create a Gage R&R measurement plan, followed the plan to measure 10 bags of M&M's twice each in a random order, and then analyzed the measurement results.



Results generated using **Stat > Quality Tools > Gage Study > Gage R&R Study (Crossed).**

The resulting total Gage R&R percent study variation of 1.14% is well below the 10% ideal, indicating that very little variation was due to the measurement system. In addition, the R Chart is in control, while the XBar Chart is out-of-control. Therefore, our measurement system is acceptable.

A Delicious Lesson

As we've seen, adding M&M's or a similar sweet to your lesson plan is a fun and engaging approach to what is often seen as an unappealing or intimidating subject. It also gives students a hands-on experience in using statistics to understand and enrich their lives. If you have the opportunity to try this technique with your students, we hope you enjoy the experience (and the M&M's) as much as we did.

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Visit **www.minitab.com** *for more information about statistics.*