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| **Title: Statistical Analysis and Significance.** |
| **Learning goals**:   1. Define statistical probability, and understand the importance of dataset-size in experiments. 2. Apply concept of statistical probability and significance in experimental design. 3. Calculate significance of obtained experimental results using Chi-Square Test. 4. Evaluate data by examining p-value. |
| **Instructions for the faculty**:  This activity requires the use of computers, or calculators (basic calculator is sufficient) .  This is a subunit of the **Van Halen and Brown M&Ms** teachable unit. In the core teachable unit, importance of dataset size and experimental setup was explained intuitively. In this subunit, mathematical calculations are used in order to explain the concept and importance of statistical significance and how significance is reached with greater dataset size. Students will also calculate the significance of their results using a Chi-Square test.  Note: Calculations of standard deviation, standard error and confidence intervals are not included in this lesson, but questions around these concepts might arise and faculty should be prepared to respond to them.  This is a good starting point to lessons on meta-analysis and review studies, or evaluation of primary papers.  ASSUMED PRIOR KNOWLEDGE: Some Math. How to calculate percentages. How to read mathematical formulas. Excel skills, especially formulas if possible. I found it best to team up students with some excel experience and those with none. Formulas needed are described in Student\_UsefulExcelFormulas. If you choose to walk-through this exercise, then no excel skills needed.  FACULTY SPECIALIZED KNOWLEDGE. Knowledge of excel, and how to use formulas in Excel. Basic understanding of statistics and probability. Much of the class is explained in the notes (Faculty\_StatSig\_ANSWERKEY) |
| **Intended outcomes**:  After this activity, students should recognize the importance of statistical significance in science and analysis of results. They should be suspicious when faced with data with no analysis/ significance. |
| **Assessment**: At the end of this activity, all students should be able to do a Chi-square test on the results of their experiment. They should also be able to apply understanding of p-values in order to evaluate published results. |
| **Activities**:   1. This activity should start after giving out the student\_FoodScientistHershey activity. Follow instructions for hypothesis and null hypothesis discussion, then split up into groups and allow them to discuss statistical confidence; for about 5-10 minutes. 2. Discuss the importance of sample size in getting significant results, using the Faculty\_StatSig\_ANSWERKEY as a guide; which will also refer to the Faculty\_StatSig excel document for class activities. This will allow the students to understand the importance of sample size and statistical significance and learn how to use Excel to both calculate power of sample size, and to draw graphs of normal distribution. 3. Allow students to complete the Experimental Conditions of the activity worksheet. Discuss. 4. Let students run experiment and collect results. It would be useful if you taught students how to record results using Excel. They can then use excel to calculate percentages and draw graphs later. 5. Discuss how they would know if results are significant. Teach how to calculate significance using Chi-Square and to draw graphs of results. 6. Ask that they make conclusions based on their results and statistical tests. Emphasize that scientific differences must be significant. 7. In order to emphasize the importance of this lesson, we can then take the example of vaccine and link to autism. I have provided here an analysis of Wakefield’s 1998 LANCET paper, along with answer key. Though this paper was later discredited due to ethical considerations and scientific fraud, the analysis here takes data in the paper, and examines if it supports claims that this paper shows correlation between MMR vaccination and ASD (Autism Spectrum Disorder). |